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MILK SANITATION ADMINISTRATION. SELECTED
LECTURES FROM COURSE NUMBER 333, 16-20
FEBRUARY 1959

Hugh E. Eagan

Communicable Disease Center
Atlanta, Georgia

1959

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MILK SANITATION ADMINISTRATION



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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE



TRAINING PROGRAM
ENVIRONMENTAL HEALTH SERIES

Milk Sanitation Administration

Selected Lectures From Course No. 333
February 16-20, 1959

Edited
By
Hugh E. Eagan
Milk and Food Training Consultant



U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE, Bureau of State Services
Communicable Disease Center, Training Branch
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I

PREFACE

The training program of the Communicable Disease Center provides a major means of disseminating the findings of research for the development of improved methods for the control of communicable diseases. It is our sincere desire that the publication of these selected lectures will contribute to continuing improvement in milk sanitation practices.

We gratefully acknowledge assistance provided by the Milk and Food Program and Robert A. Taft Sanitary Engineering Center of the Public Health Service, other Federal Agencies, and by professional and individual organizations.

Donald S. Martin, M. D.
Chief, Training Branch

FOREWORD

The importance of milk and milk products to the nutritional well-being of the individual is widely recognized. Public health authorities realize that the prevention of the transmission of disease requires maximum protection of products from point of origin through the pasteurization plant to the ultimate consumer. The processing procedure demands complete understanding of such things as cleaning-in-place procedures, ultra-high temperature pasteurization, and process control instrumentation. The need for standardizing inspection techniques to facilitate the interstate and intrastate shipments of milk and milk products must also be closely scrutinized.

As one of its major functions, the Communicable Disease Center analyzes research in the control of communicable diseases, and, in cooperation with the Division of Engineering Services, Milk and Food Program, disseminates this information to State and local health departments, personnel of related health professions, and to industry. To accomplish this more readily, the Training Branch of the Communicable Disease Center conducts regularly scheduled courses at headquarters and in the field, utilizing both the staff of the Public Health Service and consultants from universities, industry, and other governmental agencies. Reference material, audiovisual aids, and consultative services are made available to the States on request for the development of state-sponsored training programs and to provide exchange of information on current research and field developments.

The following collection of lectures from the Communicable Disease Center Course Number 333, Milk Sanitation Administration, is assembled to make this material available to the vast number of persons who are concerned with the prevention of the transmission of disease through milk and milk products.

Herbert H. Rogers
Chief, Environmental Health Training Section

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MILK SANITATION ADMINISTRATION

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I. Introduction

1. It has often been said that the effectiveness of a milk sanitation program is directly the results of an effective administrator of that program. Unfortunately, the early administrators were opinionated on certain ideas of an effective program as well as being individualistic in their approach to the problems of sanitation and the relationships of the industry with control agencies. This attitude led to confusion in the industry itself and the control agencies relationship with industry and with other health control agencies.
2. In 1924, the Public Health Service in cooperation with the State of Alabama promulgated an ordinance and code, which the Public Health Service introduced to States and local governmental bodies, as a uniform set of standards that would tend to alleviate the confusion of the dairymen, the milk plant operator and the consuming public. This ordinance and code set forth sanitary standards, as well as defining certain milk and milk products, which had public health significance in the control of communicable diseases. We still experience a diversion of opinion among controlling authorities in the United States, but to a lesser extent than experienced in the 1920's or 1930's. It is gratifying to know that at the present time the milk ordinance and code recommended for adoption by the Public Health Service serves as a basis for regulations in 36 States, and has been voluntarily adopted by over 1900 counties and municipalities throughout the United States. The influence of this ordinance and code is noticed in practically every

milk regulatory standard that has been adopted by States and municipalities throughout the U. S. Because of climatic conditions and other considerations, including opinionated administrative decisions, political interference, economic consideration and individualistic reactions, the ordinance and code may not have been adopted per se. It is noted, however, unless the ordinance and code has been adopted in the equivalency of the minimum standards set forth by the Public Health Service Ordinance and Code, it is not considered in these compilations.

3. One must consider that the health agencies in this country have been charged by the legislative authority to enforce sanitation standards affecting approximately 12,000 milk plants. These plants employ approximately 290,000 milk plant employees. One has only to reflect for a moment to recognize the economic significance that these plants have on the individual community as well as the nation. The administration of a public health program which affects the livelihood of so many people must be one of reason and must be equitably applied to all concerned. On the other hand the administrator must recognize his responsibility to the individual as well as to the community to assure a product that is clean, wholesome and above all safe for human consumption.

II. Administrative Functions

1. The public health administrator should have the ideal to conserve and improve the health of our nation. To accomplish this ideal certain fundamental functions must be accepted by the industry and the administrator, whose endeavors are fused into a common purpose. These functions may be divided into three general categories:
 - a. The prevention of animal disease being disseminated from diseased animals to man through the medium of milk;
 - b. The prevention of a communicable disease of man reaching other individuals of a community;
 - c. The improvement of man's nutritional status to raise the factor of the resistance to disease as well as to prevent physical defects that may arise from malnutrition.

These focal points provide the basis for the development of environmental, and bacteriological standards which govern the handling and processing of milk and milk products. As milk plays an important part in the nutritional program, the administrator must also be conscious of the economic factors involved as well as the acceptability of the product by the consumer. It must not be only a safe product, but it must be a food that is acceptable to the palate.

III. Our Present Status of Control Measures

1. The record for the reduction of milk-borne diseases for the past twenty-five years is an enviable one. The application of sanitary standards for the control of the environment and the use of bacteriological sciences by control agencies have had a dramatic effect in a relatively short time. It must be pointed out, however, that as one milk-borne disease after another has been reduced in its intensity, the public administrator, as well as the individual, may lose the intimate awareness of the consequences of the given milk-borne disease outbreak. However, the host parasitic relationship of one disease or another may reach unpredictable heights at any time. Experience has taught us that dysentery, typhoid fever, dyptheria, septic sore throat, brucellosis or other diseases may reach the epidemic stage without notice whenever continuous vigilance has been slackened.
2. More recently, because of economic factors, an increase in bovine tuberculosis has been noted throughout the United States. The Livestock Sanitary Authority of the United States Department of Agriculture is aware of these increases and now has under consideration the elimination of the six-year plan of modified accredited areas in order to bring more accurate control over our milk producing animals. The administrator might take the attitude that pasteurization will effectively, and I believe it will, control the virulence of the tuberculin organism. It must be pointed out that the health control official in his over-all preventative program is interested both in the individual who is handling these diseased animals, and in considering errors in the pasteurization process which have been made and in all probability will be made in the future.
3. The pasteurization of milk has had wide acceptance in this country and is directly responsible for the excellent control of milk-borne diseases. It is estimated by the Public Health

Service, Division of Sanitary Engineering Services, that 90% of all the milk consumed by the urban population is heat treated. Although the figures for our rural population are not available, it is well known that pasteurized milk is sold in the rural areas in ever increasing amounts. Home pasteurizers on the farm and in small communities are extensively used. However, there is an alarming amount of raw milk still being consumed daily throughout our nation and in rare instances is sanctioned by health control authorities. The 1950 census showed that 116 cities in the United States have a population of over 100,000 people. In 64 (or 60%) of these cities the regulatory standards permit the sale of pasteurized milk only in the community. In 19 other cities pasteurization of all the milk is required except that certified milk may be sold. Three other cities require the pasteurization of all milk, but permit the sale of raw certified milk upon a doctor's prescription. Thus we might say that 82% of any of our largest centers of population receive pasteurized milk today.

IV. Trends Within the Industry

1. We are experiencing at the present time a tremendous impact of change in the fluid milk industry. On the farms we have pipe line milkers, cold wall tanks. These are accepted by the industry and we are experiencing two and three-day "pick-up". We must acknowledge the fact that the bacteria flora under these conditions is greatly changed from our experience of even ten to twenty years ago. The economy involved is also influencing the number of participating dairies. The number of producing farms at the present time is being constantly reduced while the production of milk on those remaining farms is constantly increasing. The introduction of our modern equipment has made it imperative that the producer as well as the plant operator operate on a large volume of milk, if it is to be profitable. Thus, the milk from a single source of supply may be distributed over a wide geographical area, in order to maintain this volume of milk. We see milk coming across State lines, having been produced in areas of low cost production for other areas of high cost of production. This trend increases a geographical size of the pandemic disease potential, while the disease control factor of dilution is reduced.

2. Another development that has taken place since World War II is the extended use of agricultural chemicals on the fields and as insecticides. The widespread use of antibiotics for the treatment of mastitis in dairy cattle has introduced a potential public health hazard to which attention must be given by State and local milk control authorities. We also know that contamination of milk by radioactive substances may present a problem of considerable public health importance. While noting that this contamination is of relatively insignificant importance at the present time, it calls for constant surveillance by national, State and local authorities.

V. Modern Trends in the Pasteurization Process

1. The basic pasteurization time-and-temperature relationship of 143°F. for 30 minutes was well established by the Endicott, New York experiments of 1925. However, recently it has been shown that 143°F. for 30 minutes was not conclusive evidence that the organism causing Q fever (*Coxiella burnetti*) are not inactivated by these temperatures. The present recommendation of the Public Health Service is that milk be pasteurized at 145°F. for the full 30 minutes. However, when milk of high sugar or fat content are pasteurized the temperature should be 150°F. for the vat process. Our present standard for the high temperature-short time pasteurization of 161°F. for not less than 15 seconds is effective on market milk, but here again whenever high fat or high sugar content of milk is to be pasteurized the temperature should be increased at least 5°F. This is particularly true wherever Q fever is endemic. It may be noted that the incidence of Q fever in animals, as reported by numerous States, has been on the increase particularly in slaughtered animals. The Public Health Service at the present time recognizes the temperature of 194°F. when milk is pasteurized under the accepted controlled Vacreator process.
2. More recently intensive research data on ultra-high temperatures of pasteurized milk has brought in new equipment to the pasteurization plant, and has changed the thinking of control authorities. Here we have to recognize that there is a considerable consolidation of dairy plant processing into fewer large operations. This is done of course to reduce labor costs, permit the more effective use of automation and the specialized equipment, as well as to maintain a longer shelf life for the product. Another economic factor is the higher costs of milk

distribution to the final consumer. We now have the industry endeavoring to cut down on the largest single costs of dairy plant operation, that of retail delivery. A search of recent studies indicates that it is possible to preserve milk, as a fluid milk, during the months of peak supply for such time as the supply is lower.

3. At the present time we have under experiment in various plants throughout the country, the pasteurization of milk at temperatures between the range of 200° F. - 250° F. It is also interesting to note that we have equipment being produced in this country at the present time by which milk may be pasteurized at temperatures above 300° F. The research work relative to the keeping quality of this product, as well as to the inactivation of pathogenic bacteria, is incomplete. We may classify the product of the process as being practically sterile. It must be pointed out that at these high temperatures, factors of quality and the inactivation of spore-forming bacteria are considered, as well as the economic processing factor.

VI. The Public Health Problem

1. As our present trends for the handling of milk and milk products affect all of the relationships of the individual with his natural surroundings, which includes his diet, housing, his working and traveling conditions, we must develop a program in keeping with this modern concept. The alert Public Health Administrator must exert his ingenuity for the benefit of mankind. It is an accepted fact that no single health profession can be expected to fill the needs of an adequate health program. It may also be noted that no single concept of public health is the answer to all the people's needs. In keeping with this modern concept, the phrase "Epidemic Intelligence" has taken on a new name in the vocabulary of the public health worker. If we accept the fact that the regulatory standards that are now promulgated are effective in the control of communicable diseases, the health worker must maintain a constant surveillance of those factors affecting the production, handling, pasteurization and distribution of milk and milk products. He will therefore need the close relationship of other public health workers as a team to observe the incidence of disease, whether it be infectious, communicable, or of a noninfectious nature.

This is necessitated by the many factors that have developed as a result of the introduction of new processing methods. It is only with the concept of team endeavor that this milk control program may be effective.

Summary

The ever changing modes of operation within the milk industry will determine the public health programs of the future. The control agency must deal with the individual of his community in his relationship with life itself.

An epidemiological intelligence procedure should supplant the policing techniques of the past. The administrator must accept the facts that while the close scrutiny of sanitary standards of the environment and bacteriological flora of milk is important, he must also be aware of the effect that the new trends in pasteurization and the handling of milk may inflict on his community. He must consider the nutritional values as well as the controlling factors for the suppression of communicable diseases. The administrator, therefore, must be not only cognizant of the problems of the past, the present environmental conditions surrounding the production, processing and distribution of milk, but in addition he must be constantly aware of the need for the evaluation of the trends taking place in order to build a strong basic structure for an effective future program.

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FUNDAMENTAL SERVICES OF OFFICIAL PUBLIC HEALTH REGULATORY AGENCIES

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I. Introduction

1. In the opening lecture of a training course, such as this one on "Milk Sanitation - Administration," it is of value to develop background against which the subject can be viewed in proper perspective.
2. To develop proper perspective for this subject I wish to first discuss the public health reasons for milk sanitation programs, and the organizational pattern for sanitary control of milk which has developed in the United States over the past 50 years. I then propose to outline the fundamental services performed by milk sanitation agencies at all levels of government.

II. The Relation of Milk to Disease

1. It is paradoxical that milk which is such an important food-one which is often called nature's most perfect food - should serve as a vehicle for the transmission of disease. Yet, as we all know, milk is an excellent medium for the growth of disease organisms. In the early days of this country it was responsible for a large number of disease outbreaks, and was a contributing factor to the high infant mortality experienced at that time.
2. Diseases which are transmissible through milk will be discussed by other lecturers later in this training course; however, I would like to mention some of the diseases known to have been involved in milk-borne outbreaks.

- a. Bacterial Infections - Brucellosis, bovine tuberculosis, typhoid fever, salmonellosis, scarlet fever, dysentery, septic sore throat, and diphtheria.
 - b. Bacterial Toxins - Staphylococcal food poisoning.
 - c. Rickettsial Infections - Q fever.
 - d. Viral Infections - Scientific evidence is lacking as to the role of milk in the transmission of viral diseases. Research is needed in this area.
3. Although milk-borne disease in the United States has been reduced practically to the vanishing point by the application of sanitary practices to milk production and processing, by the adoption of cattle-disease eradication programs, and by pasteurization of a very high percentage of our market milk supplies, occasional milk-borne outbreaks still occur as the result of poor practice or negligence. Therefore, the maintenance of milk sanitation programs at a high level of effectiveness is vitally necessary to protect the public health.

III. Other Public Health Hazards Associated With Milk

1. The development and expanded use of new agricultural chemicals, particularly insecticides, following World War II, and the widespread use of antibiotics for the treatment of mastitis in dairy cattle, have introduced potential public health hazards to which attention must be given by State and local milk sanitation authorities. A detailed discussion of this topic is scheduled for presentation later in the course.
2. The contamination of milk with radioactive substances also presents a problem of considerable public health significance. This subject, too, will be discussed later in the course, and PHS activities for radiation surveillance of air, water and milk will be described at that time.

IV. The Sanitary Control of Milk Is a Public Health Problem

1. The purpose of milk sanitation programs is to protect the public health.

2. Therefore, the sanitary control of milk should be carried out by health agencies who have the basic responsibility for protection of the public health and whose staffs are trained in the sanitary sciences.

V. Legal Responsibility for Milk Control

1. In the United States, the authority for sanitary control of milk is vested in the States, except where interstate commerce is involved.
2. This authority is derived from the "police powers" of the States to protect the health and welfare.
3. In many States, by legislative act, authority for protection of public health, including sanitary control of milk, has been delegated to municipalities and other local jurisdictions.
4. Experience has shown, that for our type of dairy industry, local supervision is perhaps the best method of exercising sanitary control over fluid market milk and non-sterile milk products. In most States, this is the type of supervisory control which has developed.

VI. Responsibilities of Various Governmental Agencies for Milk Control in the United States, and Organizational Pattern

1. All levels of government in the United States play a role in the sanitary control of milk.
2. States
 - a. The States have the basic responsibility for regulating the sanitary control of milk and dairy products sold intrastate.
 - b. Within the States, the pattern of enforcement of sanitary control of milk varies, as follows:
 - (1) State-wide enforcement of State law or regulations.
 - (2) Delegation of enforcement of the State law to local health agencies in those jurisdictions having full-time local health units, with the State carrying out enforcement in areas without local health departments.

- (3) Authorization by State legislative act to local jurisdictions to adopt their own milk ordinance or regulations if consistent with State law. In such States, State enforcement, as a rule, is usually quite limited, and the State Health Department provides consultative and technical services to local health units in support of local milk sanitation programs.

c. The administrative organization for the conduct of State milk control programs also varies.

- (1) In some States, the State Health Department is solely responsible.
- (2) In others, the State Department of Agriculture is the sole agency.
- (3) In a few States, the responsibility is divided between the State Department of Health and the State Agriculture Department.
- (4) In one State, authority is vested in the State Livestock Sanitary Commission.
- (5) This division of responsibility between State agencies is confusing, and has frequently resulted in weak programs of public health protection. Since the purpose for the sanitary control of milk is to protect the public health, it is my view that authority for the conduct of milk sanitation programs should be vested in health departments which are consumer-protection agencies.

3. Municipalities and Local Jurisdictions

- a. Municipalities and counties have the responsibility for regulation of the sanitary quality of milk and milk products sold within their jurisdictions unless the State law provides otherwise.

- b. In the past, many municipalities have abused this authority, and have unjustifiably used health regulations as economic trade barriers to prevent the free movement of high quality milk. Some municipalities still follow this practice, but, many others no longer permit their health regulations to be used for this purpose.

4. Federal Government

a. Statutory responsibilities of the Federal Government.

- (1) Regulation of interstate commerce in milk and dairy products. (The Federal Government has not chosen to date to exercise this authority with regard to fluid market milk supplies, since it has been believed that sanitary control can best be achieved through State and local supervision.)
- (2) Regulation of foreign commerce in milk and dairy products.
- (3) Provision of advisory services and technical assistance to States, municipalities, and industry in support of effective State and local milk sanitation programs.
- (4) Grading of manufactured dairy products. (Voluntary programs.)
- (5) Price control - Federal Milk Marketing Laws and Orders.

b. Federal Agencies Involved.

- (1) Food and Drug Administration, U. S. Department of Health, Education, and Welfare.
- (2) U. S. Department of Agriculture.
- (3) Public Health Service, U. S. Department of Health, Education, and Welfare.

VII. Services Rendered by Official Agencies

1. Services Rendered by State Agencies

- a. Enforcement of State law or regulations. The degree of State enforcement, as previously mentioned, varies with the pattern of operations in the respective States.
 - (1) Conduct of field inspection services.
 - (2) Conduct of bacteriological, chemical and physical examinations.
- b. Promotion of uniform local regulations.
- c. Provision of technical and consultative services to municipalities and counties. (This service varies with the States.)
- d. Training of local personnel.
- e. Appraisal and evaluation of local milk sanitation programs.
- f. Epidemiological investigation of disease outbreaks.
- g. Public education.
 - (1) Promotion of pasteurization, including home pasteurization in rural areas.
 - (2) Promotion of increased milk consumption.
 - (3) Enlistment of support from civic groups and the public.
- h. Cooperation with State dairy industry organizations.
 - (1) Utilization of advisory boards made up of representatives from industry, civic, and other interested groups.

- (2) Provision of technical assistance to dairy industry on various problems.
- i. Research, investigations and studies in support of State and local programs.
- 2. Services Rendered by Local Agencies
 - a. Enforcement of local milk sanitation regulations.
 - (1) Conduct of dairy farm and pasteurization plant inspections.
 - (2) Conduct of laboratory examinations of milk and milk products.
 - b. Public education.(The functions of local jurisdictions in this area are similar to those provided by the States.)
 - c. Training of local personnel.
 - d. Cooperation with local dairy industry.
- 3. Regulatory Responsibility of, and Services Rendered by Federal Agencies
 - a. Public Health Service
 - (1) Primary responsibility of the PHS in the sanitary control of milk is to assist States and municipalities in the prevention of milk-borne disease. This function is authorized by the "Public Health Service Act," and PHS responsibility is carried out through conduct of the following activities:
 - (a) Development of model ordinances, codes and manuals recommended for State and local adoption.
 - (b) Conduct of research and investigations.
 - (c) Participation with States and industry in the conduct of voluntary programs for certification of interstate milk shippers.

- (d) Conduct of training programs for State personnel.
 - (e) Cooperation with national health and industry groups in the development of uniform standards for sanitary design and construction of milk equipment.
 - (f) Provision of technical services to States and industry in the application and administration of effective milk protection measures.
- (2) Statutory responsibility for enforcement of the interstate quarantine regulations with respect to the sanitary control of milk and milk products served on interstate carriers such as trains, buses, ships and airplanes.

4. Food and Drug Administration

- a. The FDA enforces the Federal Food, Drug and Cosmetic Act, which Act regulates the wholesomeness and labeling of food imported, shipped, or offered for sale in interstate commerce. This includes the establishment of standards of identity for certain foods including dairy products, inspection of food processing plants engaged in interstate commerce, seizure and impoundment of misbranded, adulterated and unwholesome products, and initiation of punitive action against violators.
- b. FDA also conducts research and develops necessary methods to meet problems in the application of the Food, Drug and Cosmetic Act.
- c. The FDA is also charged with responsibility for enforcement of the "Federal Import Milk Act," and the "Filled Milk Act," and "Food Additives Act."

5. U. S. Department of Agriculture

- a. USDA is authorized, as a service to the agricultural industry, to grade manufactured milk products, including butter, cheese, and dry milks. This is accomplished through voluntary grading programs.

- b. USDA is responsible for the prevention and control of plant and animal diseases, including the interstate spread of such diseases. This includes the eradication of brucellosis and tuberculosis in dairy cattle.
- c. The USDA is also responsible for enforcement of the "Federal Insecticide, Fungicide and Rodenticide Act."
- d. USDA administers Federal milk marketing orders.

VIII.

Dairy Industry Responsibility in Sanitary Control Programs

- 1. The milk industry has the responsibility of supplying the public with a safe and wholesome product. This requires day-to-day compliance with applicable local, State and Federal laws and ordinances.
- 2. The local milk industry should cooperate with health agencies, in every way possible, in the conduct of milk sanitation programs.
- 3. State dairy industry organizations should cooperate with the State milk sanitation agency in the attainment of common objectives.
- 4. National dairy industry organizations are presently cooperating with the PHS and with the International Association of Milk and Food Sanitarians in the development of 3A Sanitary Standards for Dairy Equipment, and in the development and dissemination of technical information. These National organizations should also provide support for uniform and effective milk sanitation programs at all levels of government.

PUBLIC HEALTH SERVICE MILK SANITATION ACTIVITIES AND THEIR RELATION TO STATE AND LOCAL PROGRAMS

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I. Program Objective

1. The objective of the milk sanitation program of the Public Health Service is the protection of the public health through the prevention and control of milk-borne disease.
2. As protection of the public health is primarily the function of State and local governments, except when specific problems of an interstate nature are involved this objective is carried out through provision of assistance to States in the development and conduct of effective milk sanitation programs.
3. PHS activities are basically non-regulatory in nature, although, as will be discussed later, the Service does have statutory responsibility for the sanitary control of milk and milk products served on interstate conveyances.

II. Historical Development of Public Health Service Milk Sanitation Program

1. The interest of the PHS in milk as a factor in the spread of disease dates back to 1896. However, activities directed toward the prevention and control of milk-borne disease were not initiated until 1906.
 - a. In 1906, an investigation by the Service of typhoid fever in the District of Columbia revealed that milk was the agent of transmission in 10 percent of the 866 cases studied. This led to the conduct of comprehensive studies of the relation of milk to the public health. The results

of these studies, published in 1908 and 1909, together with the work of other investigators, firmly established that milk was a medium for the transmission of disease and that the incidence of milk-borne disease in the United States was an important public health problem.

- b. Concurrently, studies were made by Rosenau and associates of the thermal death points of pathogenic microorganisms in milk.
2. Following this classic work, the PHS took an active role in various efforts directed toward protection of municipal milk supplies, including the certified milk movement, and provided technical assistance and consultation in planning and developing municipal programs. However, additional studies indicated that even elaborate sanitary precautions recommended for the production and handling of certified raw milk were not sufficient to prevent milk-borne disease outbreaks, and the conclusion was reached that commercial pasteurization must be extended to provide adequate consumer protection.
3. In 1921, the Service cooperated with a large dairy corporation and a commercial public health laboratory in a comprehensive study of time and temperature standards for commercial pasteurization and of the efficiency of various types of pasteurizing equipment. The results of this investigation, published in 1925 indicated that the pasteurization process was subject to misoperation, and much of the existing equipment was faulty in design and construction. These early studies led to the further conclusion that sanitary control of production followed by effective pasteurization was essential for the prevention of milk-borne disease outbreaks.
4. In 1923, the State of Alabama requested the assistance of the Public Health Service in the development of a State-wide milk control program. This action led to the establishment of an Office of Milk Investigations within the Public Health Service, whose basic function was to assist States and municipalities in the prevention and control of milk-borne disease.

III. Organizational Structure of Current PHS Milk Sanitation Program

1. The current milk sanitation activities of the PHS are conducted by the Milk and Food Program, Division of Engineering Services, Bureau of State Services.

- a. Headquarters Office (Washington, D. C.) - Responsible for program planning, technical direction, and project development.
 - b. Robert A. Taft Sanitary Engineering Center (Cincinnati, Ohio) - Responsible for research, special studies and investigations.
 - c. Regional Offices - Responsible for provision of technical assistance and consultative services to the States.
- 2. Supporting services are provided the Milk and Food Program by other components of the Service.
 - a. Communicable Disease Center - Training and investigations of milk-borne disease outbreaks.
 - b. National Institutes of Health - Related Research.

IV. Products Covered by Current Program

- 1. Fluid milk and fluid milk products.
- 2. Dry milks used in the reconstitution or manufacture of fluid milk and milk products defined in the Milk Ordinance and Code.
- 3. Cottage cheese.
- 4. Frozen desserts.

V. Program Aims

- 1. As enforcement of milk sanitation regulations in the United States is primarily the responsibility of State and local governments, the milk sanitation program of the PHS is designed to assist State and local regulatory agencies and the milk industry.
- 2. Program aims are:
 - a. To encourage the establishment of effective and well balanced milk sanitation programs in each State;
 - b. To encourage the adoption of practical, but adequate, State and local sanitation standards;

- c. To provide technical assistance on problems and new developments, which have public health significance, to State and local agencies and to industry;
 - d. To encourage industry support of, and day-to-day compliance with, State and local milk sanitation programs; and
 - e. To stimulate increased consumption of pasteurized milk and milk products as a positive public health measure.
3. To implement these aims, the Service engages in a number of coordinated and related activities which can be grouped broadly into six major categories as follows:
- a. Development of recommended sanitation standards, technical procedures and other program guides;
 - b. Conduct of research and investigations, including epidemiological investigations of milk-borne disease outbreaks;
 - c. Provision of technical and advisory assistance to States, municipalities, and industry;
 - d. Education and training;
 - e. Development of sanitary criteria for the design and construction of dairy equipment; and
 - f. Interstate program responsibilities.
4. In carrying out these activities, the Service acts solely in an advisory, consultative and research capacity, except on those matters concerned with the sanitary control of milk served on interstate carriers.

VI. Program Activities

1. Development of Program Guides

- a. The development of program guides which are recommended for use of interested States and municipalities is a fundamental part of the PHS program.

b. Milk sanitation program guides published to date include:

- (1) Milk Ordinance and Code
- (2) Frozen Desserts Ordinance and Code
- (3) Methods of Making Sanitation Ratings of Milk Sheds
- (4) Model Inspection Forms
- (5) Grade A Dry Milk Products - A Sanitation Ordinance and Code for Dry Milk Products Used in Grade A Pasteurized Milk Products. This guide was recently completed and will be published soon as Supplement #1 to the Milk Ordinance and Code.

c. Perhaps the best known of these program guides is the Milk Ordinance and Code.

- (1) Its preparation was an outgrowth of experience gained in assisting the State of Alabama in 1923 in the planning of a State-wide milk sanitation program. A study of the differences among State and municipal milk regulations in force at that time led to the conclusion that a uniform approach was necessary for the control of milk-borne disease, and also would be fairer to the industry.
- (2) To provide assistance to those States and municipalities interested in initiating milk sanitation programs, the Service developed and published in 1924 a "Standard Milk Ordinance." To provide for uniform interpretation of this Ordinance, an accompanying code was published in 1927. The code set forth the public health reason for each requirement, and provided details as to satisfactory compliance.

- (3) The Milk Ordinance and Code has been revised twelve times to keep abreast of modern techniques and new procedures in dairy science, public health, veterinary medicine and related fields. The last complete revision was published in 1953.
- d. The Milk Ordinance and Code is not a product of the PHS alone. The Service utilizes the following developmental procedure which is intended to insure public health adequacy and nation-wide applicability.
- (1) Each edition is developed with the aid of a national advisory committee whose members include public health and industry representatives, as well as experts in the field of dairy science.
 - (2) Research findings, technical developments and changes recommended by official agencies, industry, and others, are carefully reviewed and evaluated.
 - (3) The advice and assistance of the U. S. Department of Agriculture, the Food and Drug Administration, industry organizations, and educational institutions are solicited on specific problems.
 - (4) Following these steps, a draft is prepared and circulated to State and Federal agencies, selected municipalities, industry groups and others concerned for review and comment. All comments received are carefully considered and acted upon by our advisory committee before completion of the new edition.
 - (5) This same technique is followed in the development of other recommended standards and program guides.
- e. These recommended standards and program guides have filled a need. This is well indicated by the extent of their acceptance and use.

As examples:

- (1) The Milk Ordinance and Code now forms the basis for the regulations of 36 States. It is in

effect on a State-wide basis in 14 of these States. It has also been adopted by more than 1900 counties and municipalities. The Milk Ordinance and Code has also been made a part of the Federal Specifications for milk, and it is used as the yardstick for the rating of milk supplies shipped interstate under the Cooperative State-PHS Program for the Certification of Interstate Milk Shippers.

- (2) Methods of Making Sanitation Ratings of Milk Sheds is also widely used throughout the United States, and has been a model for development of other public health appraisal techniques. (Its use will be discussed in more detail in a lecture to be presented to this group on Tuesday.)

2. Research and Investigations

- a. The conduct of research, the development and testing of new methods and procedures, and the evaluation of the public health significance of new processes, techniques and equipment, are also a fundamental part of our program. These activities are conducted primarily at the Sanitary Engineering Center, Cincinnati, Ohio. However, the National Institutes of Health, Bethesda, Maryland, from time to time, engage in research, the results of which have a bearing on milk-borne disease problems, and the Communicable Disease Center, Atlanta, Georgia, conducts research on animal disease problems, insect vector control, and insecticides. The Communicable Disease Center also provides assistance to the States in the conduct of epidemiological investigations of milk-borne disease outbreaks.
- b. Initially, most of the Service research effort was devoted to the investigation of pasteurization equipment, and to the development of technical procedures that could be included in the recommended Milk Ordinance and Code. Much of this work was done in cooperation with various State health departments and with industry. The results of this work led to, or contributed to:

- (1) Improvements in the design and efficiency of commercial pasteurization equipment, including the development of automatic controls and other safety devices to insure proper pasteurization;
- (2) The establishment of an adequate time and temperature standard for high-temperature short-time pasteurization; and
- (3) The establishment of procedures and standards for the bactericidal treatment of dairy equipment.

c. Studies completed in recent years include:

- (1) Staining procedures for the microscopic examination of milk;
- (2) The effect of inhibitors in natural waters on the germicidal action of quaternary ammonium compounds;
- (3) Determination of the germicidal properties of chloramine-T, quaternary ammonium compounds, chloramelamine, iodine and bromine;
- (4) Investigation of the design and operation of home pasteurization units; and
- (5) Determination of the thermal death curve in milk of C. burnetti, the causative agent of Q fever (cooperative project with the University of California.)

d. Current research projects of interest include:

- (1) Studies of measurements of flow times of milk and water in closed systems, such as high temperature pasteurization equipment, using radioisotope tracer techniques;
- (2) A pilot study of radioactivity in milk. This project is a part of the over-all PHS continuing radiation surveillance activity for measurement of amounts of radioactivity in water, air, milk and other foods. (A paper on the results obtained to date through this study is to be presented to this group on Wednesday afternoon.)

- (3) A study of staphylococcal enterotoxin in milk and other dairy products, including studies of interfering substances in milk which cause false positives in the "cat" test.
 - e. The Service also participates jointly with industry and other groups in cooperative research projects and, as a means of stimulating research, provides grants to educational institutions for research on specific problems.
 - f. In addition to the above activities, the Public Health Service is called upon frequently by States, municipalities, industry, and other Federal agencies to test and evaluate newly developed equipment, processes, and products used in the dairy field. However, evaluations are made of only those items which have broad public health significance, or those which may, under conditions of use, present a hazard to the public.
3. Technical and Advisory Assistance to States
- a. In order to encourage, and aid in, the development and maintenance of effective milk sanitation programs throughout the nation, the Service provides a number of different forms of technical and advisory assistance to those States who request our help. Some of the types of assistance provided include:
 - (1) Review and evaluation of State and local programs, including laboratory programs, and the preparation of recommendations for improvement;
 - (2) Investigation of technical problems submitted by States and municipalities, and provision of suggested solutions;
 - (3) In-service training of State and local milk sanitarians;
 - (4) Assignment of PHS milk sanitation consultants to assist in the planning and conduct of demonstration projects, or field investigations;

- (5) Provision of interpretations on the technical aspects of the Milk Ordinance and Code and Frozen Desserts Ordinance and Code; and
 - (6) Examination of equipment to determine compliance with the sanitary design and construction criteria of the Milk Ordinance and Code and Frozen Desserts Ordinance and Code.
- b. For the most part, these services, as well as advisory services to the dairy industry, are provided by PHS regional milk and food consultants who are assisted, as required, by the staffs of our Washington Office and the Sanitary Engineering Center.
4. Education and Training Provided for State and Local Health Agency Personnel
- a. Formal training courses for milk sanitarians are conducted by the Communicable Disease Center and its field training station.
 - b. A specialized training course in the bacteriological examination of milk and dairy products is offered annually by the Sanitary Engineering Center.
 - c. In addition to these two types of formal courses, assistance is provided by both CDC and SEC to State and municipal health departments, and educational institutions, in the planning and conduct of their own training courses.
 - d. Seminars for regulatory and industry personnel are conducted by our regional milk consultants.
 - e. In-service training of State milk sanitation personnel is provided by our regional milk consultants upon request.
 - f. Training films and training guides are developed by CDC for State and local use.
5. Sanitary Design and Construction of Equipment
- a. PHS interest in the design and construction of dairy equipment is threefold. First, we are concerned with

function; second, with potential hazards to the milk supply that might result from improperly designed equipment; and third, with the cleanability of the equipment.

- (1) With regard to function, we are directly interested in only those items of equipment in which proper performance of intended function is relied upon as a public health safeguard, such as a pasteurizer and its control appurtenances.
 - (2) With regard to design hazards, we are interested in the elimination of defects in design, construction, operation or installation that provide a possible means for contamination of the product. Examples of such hazards are improper relative pressures in regenerator sections, and faulty valve design which permits contamination of a pasteurized product.
 - (3) With respect to cleanability, our interest relates to the fact that improperly designed and constructed equipment cannot be properly cleaned, and thus may constitute a source of contamination for an otherwise wholesome product.
- b. In order to provide safeguards covering these three areas of potential hazard, we have developed and included in the Milk Ordinance and Code, and other sanitation standards, detailed specifications for some types of dairy processing equipment, as well as general sanitary design and construction criteria for all equipment having milk or milk product contact surfaces.
- c. The only practical approach to equipment problems of this nature is to eliminate defects at the point of manufacture. For this reason the Service participates jointly with the Dairy Industry Committee and with the International Association of Milk and Food Sanitarians in the development of 3A Sanitary Standards for Dairy Equipment. As explained in the lecture on the 3A program presented this morning, the 3A program is an excellent example of the manner in which industry and government can work closely together for the public good. Some of the advantages of this cooperative approach in standards development are:

- (1) The views of health authorities, the processors, and equipment manufacturers all receive thorough and equal consideration.
- (2) During development of a standard, manufacturers can evaluate proposed sanitary requirements in terms of fabrication problems and costs, and processors can focus attention on practical considerations involved in utilization and operation of the equipment.
- (3) Milk equipment built in conformance with 3A standards complies with good public health practice, and State and local health authorities can accept such equipment with confidence.

6. Interstate Responsibilities

Two Public Health Service milk sanitation activities are of an interstate nature.

- a. The first of these is the approval of sources of fluid milk and milk products, and of frozen desserts, served on trains, vessels and airplanes which move interstate.
 - (1) This is a direct statutory responsibility, and Public Health Service enforcement procedures are governed by the Interstate Quarantine Regulations.
 - (2) To obtain, and continue to carry, an "Approved" status, sources must comply generally with the applicable provisions of the Milk Ordinance and Code and of the Frozen Desserts Ordinance and Code.
 - (3) Approximately 600 sources of fluid milk and milk products and 350 sources of frozen desserts currently carry an "Approved" classification.
 - (4) In order to avoid multiple inspection of individual sources, by Federal, State and municipal agencies, in its conduct of this regulatory function, the Service accepts the results of inspection and laboratory work performed by local health departments, provided that the local health departments have a

satisfactory program of supervision, and their results are transmitted through, and endorsed by, the States.

- (5) This enforcement activity is conducted by the Interstate Carrier Section, General Engineering Program, Division of Engineering Services, with the assistance from the Milk and Food Program.
- b. The second activity of an interstate nature in which the Service is engaged is the voluntary State-PHS Program for Certification of Interstate Milk Shippers.
 - (1) Basic elements of IMS Program.
 - (a) PHS participation in this cooperative program was initiated in 1951 following requests from the Association of State and Territorial Health Officers and the First National Conference on Interstate Milk Shipments.
 - (b) Under this program, which is entirely voluntary in nature, inspection and laboratory control of interstate milk supplies are performed by the States and municipalities in which the source of supply is located using the Milk Ordinance and Code and the rating method developed by the Service as uniform criteria for evaluation.
 - (c) The States report to the Service those shippers whose products and plants have been rated by them in accordance with the applicable sanitary requirements.
 - (d) The Service publishes quarterly a list of the sanitation ratings of all certified interstate milk shippers for the information of areas desiring to import milk.
 - (e) No interstate shipper's rating is published without his permission.

- (f) In order to validate the sanitation compliance ratings submitted by the States, the Service periodically spot-checks and evaluates the work of each State participating in the program.
- (2) The objective of this cooperative program is to provide a means whereby health authorities in milk-importing areas can accept with confidence milk shipped into their jurisdictions from out-of-State without the necessity of making their own inspections of distant sources.
- (3) Considerable progress has been made through this program in facilitating the interstate movement of high quality milk.
 - (a) The first list of "Sanitation Compliance Ratings of Interstate Milk Shippers," which was published in 1951, contained the names and ratings of 160 shippers located in 17 States.
 - (b) The current list includes 693 shippers located in 35 States and the District of Columbia.
 - (c) According to a survey made by Kenneth G. Weckel, of the University of Wisconsin, in which an estimated 60-70 percent of the listed shippers responded, in the year 1955 at least 25,000 shipments were made under the program.

METHODS OF MAKING SANITARY RATINGS OF MILK SHEDS

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I. The Public Health Service Milk Sanitation Evaluation System

1. No matter how comprehensive milk sanitation regulations may be, they afford protection to the consuming public only to the extent to which their provisions are followed in the production, processing, and distribution of milk and milk products.
2. The purpose of the rating method is to measure objectively the extent to which communities adopting the Milk Ordinance and Code recommended by the Public Health Service are enforcing its provisions.
3. The results of evaluations made by the rating method can be used to stimulate and encourage local health authorities toward greater effort. Many milk sanitation control agencies utilize the method to evaluate periodically the progress being made in improving the sanitary quality of market milk supplies.
4. The rating method has enabled State and local agencies to obtain authoritative information on the sanitary quality of milk imported from other jurisdictions, and thus facilitate the movement of high quality milk and milk products in both intrastate and interstate commerce.
5. In evaluating the sanitary quality of milk, the rating method measures the degree to which a milk supply complies with the Milk Ordinance and Code recommended by the Public Health Service. The Milk Ordinance and Code is used as a yardstick in order that ratings may be comparable to each other. Ratings are expressed in terms of percentage compliance.

II. Collection of Data

1. Data from which the ratings is determined are obtained from the records on file by the local health authority and from an evaluation of sanitary practices at producer dairies, pasteurization plants and receiving stations.
2. It is not necessary to inspect all plants and producer dairies since a sufficiently accurate determination of the percentage compliance with sanitation requirements can be obtained by surveying a statistically representative number of plants and producer dairies. (See Table 1 in "Methods of Making Sanitation Ratings of Milk Sheds" published by the Public Health Service.)
3. By inspecting a representative number of plants or producer dairies, selected at random, the probable error in the individual percentages of compliance with the various items of sanitation will be less than five percent. The method used in selecting the plants or producer dairies to be inspected during the survey must exclude elements of preselection and provide a true random sample.
4. Methods which are satisfactory for the random selection of either producer dairies or pasteurization plants are as follows:
 - a. The name of each producer or dairy is written on a small card. These cards are thoroughly shuffled and the number of producers or plants to be included in the survey is selected at random.
 - b. Selection can be made at intervals from a complete card index or ledger record of the number to be inspected. When this method is used, the sequence interval chosen must be such that substantially all the card index is subjected to the sampling method.
5. In milk sheds which are divided into several inspection areas or districts, the total number to be inspected may be prorated among those areas in approximately the proportion that the size of each bears to the total number of plants or producer dairies in the milk shed.

6. Receiving stations are considered an integral part of each pasteurization plant to which milk is shipped. Therefore, all receiving stations supplying the plants selected must also be included in the survey.
7. Inspection data is recorded on forms containing items of sanitation which correspond to the items of sanitation contained in the Milk Ordinance and Code. When significant violations are noted, the corresponding sanitation item is marked with an X. The number of gallons of milk and milk products sold daily is also recorded for use in computing the rating.
8. Compliance with requirements for bacterial counts, reduction time, coliform counts, and cooling temperatures is based on whether, at the time of the survey, the producer's supply or a plant's products meet the Grade A requirements of the Milk Ordinance and Code.
9. Laboratory procedures must be substantially in conformance with Standard Methods for the Examination of Dairy Products.
10. Local records may be utilized by the milk sanitation rating officer in determining performance of field tests if the milk sanitation rating officer has satisfied himself as to the competency of the local sanitarian.

III. Computation of Sanitation Compliance Ratings

1. The violations recorded on the inspection sheet for each of the producer dairies surveyed are transferred to the appropriate tabulation sheet where they are tallied. The sanitation compliance rating for "Raw Milk for Pasteurization" is then derived from the following formula:

$$\text{Rating} = \frac{\text{Total of last column}}{\text{Total gallons sold daily}}$$

2. The violations recorded on the inspection sheet for each of the pasteurization plants surveyed are also transferred to the appropriate tabulation sheet where they are tallied. If a receiving station serving one of the pasteurization plants surveyed violates an item of sanitation also violated by the plant, the receiving station entry is circled and not included

in the tabulation so as to avoid duplication of penalties. The sanitation compliance rating for "Pasteurization Plants" is derived from the following formula:

$$\text{Rating} = \frac{\text{Total of last column}}{\text{Total gallons sold daily}}$$

3. The sanitation compliance rating of pasteurized milk and milk products is the simple average of the sanitation compliance ratings of raw milk for pasteurization and of pasteurization plants.
4. Milk and milk products being received from beyond the limits of routine inspection of the health authority being surveyed are not included in the computation of local sanitation compliance ratings if the milk and milk products are being received in accordance with the provisions contained in Section 11 of the Milk Ordinance and Code. Information on the amount of milk being received from outside, along with the rating and date of rating, must be recorded on the tabulation forms.
5. When milk and milk products are being received that do not meet the provisions of Section 11, it is necessary to consider the status of such supplies in the computation of the local ratings. The raw milk for pasteurization compliance ratings of shipped-in supplies and the rating of the local supply are weighed by decimals representing, respectively, the shipped-in supply and the remaining milk volumes which together go to make up the total local sales of pasteurized milk.

For pasteurization plants the sanitation compliance rating of the pasteurization plant shipping the milk and milk product is subtracted from 100 and the difference entered in the "Total Debits" column.

6. The rating of receiving stations shipping into the community is also considered in the rating. The name of the receiving station and the gallons of milk and milk products supplied daily are entered parenthetically on the pasteurization plant tabulation sheet. If the receiving station rating is equal to or higher than that of the plant it supplies, the local plant rating is considered as being inclusive of the receiving station violations; therefore, no entry is made. If the receiving

station rating is lower, it is subtracted from the rating of the plant it supplies and the difference entered under "Total Debits" on the pasteurization plant tabulation sheet.

IV. Computation of Enforcement Rating

1. The "Report of Enforcement Methods" provides a means of measuring the degree to which enforcement provisions of the Milk Ordinance and Code are being applied and serves to delineate specific areas where a milk sanitation program needs strengthening.
2. Appraisal of the items on the tabulation form is based on the milk sanitation rating officer's observations during the survey and his review of the local health authority's records.
3. When an item requires separate action on the part of the health authority with respect to each producer or pasteurization plant, compliance is based on the proportion of producers or plants for which local records show the item to have been satisfied.
4. When an item requires more than one test or demonstration, the compliance is also based on the proportion of tests or demonstrations which, according to local records, were made at the required frequency.
5. When an item requires an action which affects the entire control program, full weight of the item is debited or credited, depending upon whether the local milk sanitation program is satisfying the pertinent provisions of the Milk Ordinance and Code.

V. Preparation of Rating Officer's Report

1. In the course of conducting a survey and computing ratings, additional facts may become apparent which, if presented, would be of value to the health authority in orienting the local milk sanitation program along lines of greater effectiveness. A supplemental narrative report including the following should be presented:
 - a. Statement as to the general status of the milk sanitation program.

- b. Discussion of specific program needs as indicated by the compliance levels of sanitation items and enforcement practices.
 - c. Statement as to adequacy of existing milk sanitation regulations.
 - d. Appraisal of adequacy of funds, personnel, facilities, etc.
 - e. Recommendations as to specific program improvements.
2. It is important that the full report be discussed in detail with the appropriate officials of the community being rated. Such discussions contribute to better understanding of the problems involved and provide the local authorities with an opportunity to discuss means of implementing the milk sanitation rating officer's recommendations.

THE INTERSTATE MILK SHIPMENT PROGRAM

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I. Need for the Program

1. The milk industry in the United States is a major industry -- over 60 million pounds of milk are required annually to fulfill consumer needs for fluid milk and milk products alone.
2. Until recently the volume of market milk shipped interstate was rather small. Today the problem is nationwide in scope, its growth being brought about by public demand for additional milk and milk products.
3. Prior to the advent of refrigeration, the production, processing and marketing of milk were considered a local affair, with each area producing enough milk to meet local demands, except during shortage periods.
4. Industrialization, increased population, urbanization -- all contributed to the need for a change and focused attention on the need for a system whereby milk deficient areas could learn of supplies that would meet their demands and standards.
5. As shortage areas began to import milk for local use, many problems developed. A major problem confronting receiving areas was the difference in standards and their application.
6. Receiving areas began to send their own representatives to shipping areas to secure information on the sanitary quality of milk to satisfy their own legal obligations. This practice created undue burdens on the pasteurization plants and producers and presented difficulties in the interstate movement of high quality milk.

7. The requirements needed to protect the consumer against milk-borne diseases should be the same regardless of geographic areas.
8. The first step in solving this problem is the acceptance of all concerned of common criteria for evaluating the sanitary quality of a milk supply. State and local authorities have the right to inspect, at the source, milk and milk products they are to receive; however, the method of inspecting these imported supplies should be made less cumbersome and more efficient.

II. Basis for the Cooperative State-Public Health Service Interstate Milk Shipper Program

1. The significance of these developments was recognized as early as 1944, when the Conference of State and Territorial Health Officers asked the Public Health Service to study the feasibility of developing a certification plan for milk.
2. In 1946, the Surgeon General directed a letter on the subject to all State milk-control authorities indicating the willingness of the Public Health Service to participate in a certification plan for interstate milk shippers.
3. Interest increased, and in 1950 the first National Conference on Interstate Milk Shipments met in St. Louis. The Conference, a forum for the discussion and resolution of interstate milk shipper problems, met again in 1951, 1952, 1953, 1955 and 1957.

III. Basic Principles of the Conference Agreements

1. The interstate milk shipper must be under the routine supervision of an official agency -- State or local. Supervision of the shipper supply shall be based on Grade A requirements of the Milk Ordinance and Code recommended by the Public Health Service or regulations substantially equivalent thereto.
2. Enforcement and compliance are measured by the rating procedures outlined in "Methods of Making Sanitation Ratings of Milk Sheds."

3. The ratings of interstate milk shippers are made by the State milk control authorities of the State of origin.
4. The ratings must be of individual shippers and their producing farms, unless the supply is a part of an area milk shed which has been awarded a rating of 90 percent or more on the basis of an official survey. All ratings must be less than two years old.
5. The interstate milk shipper supply must be under a program of routine laboratory control which has been checked by the State laboratory certification agency as complying substantially with APHA Standard Methods for the Examination of Dairy Products and with the provisions of the Milk Ordinance and Code.
6. Periodically the Public Health Service is to spot-check and certify the inspection, rating and laboratory procedures of the reporting State.

IV. Responsibilities of the Public Health Service in the Cooperative Program

1. The Service is to standardize and certify State Milk Sanitation Rating Officers. In this connection, the designation of milk sanitation rating officers is a State function, with the Service determining whether or not the individual's work is acceptable.
2. The Service is to conduct through its Regional Offices training seminars for State personnel to acquaint them with interpretations of and changes in the 1953 Milk Ordinance and Code.
3. The Service is to establish a certification system for laboratories performing examination of milk involved in interstate shipments. Here again the Service's function is restricted to the approval of State laboratory certification activities and occasional spot-checks. The certification of individual laboratories is a State function.
4. The Service is to spot-check and certify inspections and rating procedures of the reporting States. This is a vital part of the program and represents the final step in establishing the confidence between rating agencies that is needed.

5. The Service publishes quarterly a list of interstate milk shippers. For each shipper listed, there is indicated on the list:

- a. The products available for shipment.
- b. The raw milk rating, the pasteurized milk rating if pasteurized milk is available, and the enforcement rating.
- c. The date of rating and the rating agency.

The purpose of the list is to expedite the interstate shipment of milk and milk products by providing valid information on potential milk sources to those health officers and regulatory officials who have need for information on milk from outside their normal inspection areas.

V. General Comment

If the Program is to accomplish its purpose, it must have the continued support of all regulatory agencies and of the producers, processors and distributors of milk and milk products. Participation should prove to be to the advantage of all in making adequate quantities of safe milk available to all parts of the country.

CHANGES IN APHA STANDARD METHODS
FOR THE EXAMINATION OF DAIRY PRODUCTS
(11TH EDITION)

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I. Milk Analysis

The present Subcommittee on Standard Methods is organized as nine reference committees of three or four members, each reference committee being responsible for certain areas and revision of appropriate chapters. During the past year the first drafts of twelve chapters have been distributed to committee members and others for comments. Comments received have been reviewed by the reference committee chairmen and incorporated into revisions that will be issued as a second and, presumably with minor corrections, the final draft for approval by the Association at the 1959 annual meeting.

The Reference Committee on Milk Sampling and Quality Control has prepared Chapter 1 on General Quality Tests, Chapter 2 on Sampling and Chapter 9 on Miscellaneous Microbiological Methods. The texts have been entirely rewritten and arranged in a logical sequence. In the present edition Chapter 1 consists of some 75 pages of introductory material, applications, interpretations and standards for all the techniques detailed subsequently. In the 11th edition the introduction, materials, procedures, applications, and standards have been placed in the respective chapters on analytical procedures and are the responsibility of the reference committee concerned rather than being prepared largely by a single referee. This has resulted in a shorter Chapter 1, which will consider basic public health concepts for the sanitary quality of dairy products, inspection, laboratory control, screening tests, and the relative accuracy of methods of measuring sanitary quality.

New material includes a discussion of present knowledge concerning radioactivity in relation to milk, recent application of split sample tests, and a discussion of the need for new quality tests for use by either official agencies or industry. Recognition has been given

to recent studies showing that the standard plate count detected 81% of unsatisfactory samples and is a more discriminating test of bacteria in raw milk than the direct microscopic count which detected 22%, or the laboratory pasteurization count detecting 32%.

Chapter 2 covers the collection of samples of milk and cream, including apparatus, sterilization and general directions for sampling wholesale and retail samples. Special attention has been given to new material on collecting samples from large tanks, vats, etc., and en route samples from bulk farm tanks. In this connection it may be of interest to note the relationship of the average number of milk samples per producer per year tested for bacterial counts, and the average bacterial counts of the raw milk determined in studies of eight cities made for the National Research Council as reported in 1953. Only two health department laboratories tested one or more milk samples per producer per month, whereas the laboratories of the dairy industry in three cities tested monthly more than two samples per each producer, and altogether the laboratories of industry tested approximately five times the number of samples tested by health departments. The bacterial counts of raw milk of the cities decreased as the average number of milk samples tested yearly per producer increased, and it was concluded that the minimum number of samples of raw milk to be tested to maintain bacterial counts below 200,000 per ml should be two per month, with weekly retesting of milk not in compliance with sanitary regulations.

The Reference Committee on Cultural Methods, Coliforms and Psychrophiles has prepared Chapter 3 on Agar Plate Count, Chapter 6 on Coliforms and 7 on Thermotolerant, Thermophilic and Psychrophilic Bacteria. The Chairman of the committee wrote to a number of bacteriologists and had notices printed in several journals requesting documented suggestions which could be used in revising Standard Methods. He reported a slight response to personal letters but knew of not a single response to the solicitation in the journals. As a result there are only a few changes for which there is documentation and certain other changes based upon the judgment of colleagues with first-hand experience in the particular subject; for example, provision for the use of plastic petri dishes. However, the text has been entirely rewritten and arranged in a more logical sequence.

II. Dilution Water

Although Standard Methods provides a test to detect toxicity of buffered phosphate dilution water, no test has been given for determining whether the distilled water is free from toxic substances. Similarly Standard Methods for the Examination of Water, Sewage, and Industrial Wastes stipulates that distilled water shall be free from toxic substances, but does not provide any procedure for making this determination. Bacteriologists H. F. Clark and co-workers of the Sanitary Engineering Center are developing a microbiological test suitable for this purpose which will be included in the 11th edition of Standard Methods. By adding small amounts of individual chemicals to separate portions of distilled water and inoculating each with a selected culture of microorganisms, it will be possible to determine whether the distilled water contains excess amounts of nitrogen, carbon, toxic metals, etc.

III. Plating Media

On February 20, 1951, the Executive Secretary of the APHA announced acceptance and the optional use for making standard plate counts on milk, of dehydrated media made by either of two companies. Subsequently, a subcommittee on approval of culture media was formed and at its first meeting in June 1951 the members agreed that as long as the association took responsibility for approving culture media, as in Standard Methods, it should at least check batches of such media to insure uniformity and standard productivity, since most laboratory workers have neither the time or knowledge to personally test media or ingredients. At the first meeting consideration was given to a program with industry testing, submission of the results of their test to the Association, and spot checking by the Association, including, if necessary, inspection of the manufacturer's plant and facilities.

Subsequently a statistically valid method for checking culture media was worked out and accepted by the APHA Coordinating Committee on Laboratory Methods, but in 1955 it became apparent that the APHA itself would not undertake an official certification program. Accordingly in 1958 various professional organizations having potential interest in the certification of bacteriological media were asked to designate a representative for an Ad Hoc conference on this subject to consider the present need for a certification program; if needed, what type of organization should be involved; and

how the problem could be handled. At the conclusion of this conference there was unanimous opinion as to the need for surveillance of plating media, that an independent commission be set up to handle media certification, and that endorsement of the principle of media certification should be sought from the scientific societies represented by the delegates present. Task parties are currently investigating procedures for incorporation, for revision of a protocol for evaluating the quality of plating media, and for spot checking the productivity of plating media currently available commercially. If these goals are attained in the near future, probably the next edition of Standard Methods can recommend "certified" plating agars as it now recommends stains certified by the Biological Stain Commission.

The January 1959 American Journal of Public Health, page 119, announces acceptance of the optional use of dehydrated media of a third manufacturer for making standard plate counts on milk and cream by the agar plate count, effective October 27, 1958. Specimens of this media had been tested in an independent laboratory by the plan developed by the former APHA Subcommittee on Certification of Media, and statistical analysis of the data showed that the medium met the requirements previously established by the APHA.

Nevertheless, from time to time laboratories have reported anomalous results obtained in using various lots and makes of dehydrated media; not only for total plate counts but also for coliforms. Similar results have been encountered by others with samples of liquid media used for coliforms in fermentation tests, as well as for membrane filter media. English investigators have reported considerable variation of both bile salts and peptones in water bacteriology and have suggested standardization of these products. Although little has been published, an article did appear last year in a report of the Dairy Research Institute in Netherlands in which certain batches of American plating agar gave significantly lower bacterial counts than other batches or than a similar medium made up in the laboratory. However, batches received later again yielded satisfactory counts so it was assumed that the temporary defects had been overcome.

IV. Shaking and Measuring Dilutions

A deviation observed in the original surveys which is still common is the failure to shake dilution bottles approximately 1 foot in an up-and-down motion. Efforts have been made since 1949 to have

manufacturers develop a shaking machine to mechanize this operation. Such a machine was made some years ago by a mechanic in Seattle for the Seattle-King County Health Department. This machine meets the requirements for hand shaking in Standard Methods as outlined for possibly the last 50 years; namely, approximately one foot up-and-down 25 times within 7 seconds. The Seattle machine is bulky and has to be bolted to the floor and since it vibrates and is rather noisy is housed in a sound-proofed room adjacent to the plating area. Drawings of the Seattle machine were supplied to a manufacturer in 1952, but they preferred to develop a smaller machine which was displayed in 1955 at the APHA meeting. Before accepting this as equivalent to the existing requirements in Standard Methods, the manufacturer was asked to have a comparison made with the machine in Seattle. A statistical analysis of the results of the comparative study made in 1957 showed that the machine gave comparable counts on raw and pasteurized milk and thus was acceptable to the committee. However, the experimental model which had an up-and-down stroke of one inch also moved about on the floor and in order to adapt this for bench operation the manufacturer shortened the stroke in a second model. This has necessitated retesting the machine which is to be done during 1959, and, if successful, mechanical shaking may be included in the 11th edition.

Another common error in measurement is failure to allow the lower side of the pipette to contact the inside of the container as stipulated in Standard Methods. This is essential when using the 1.1 ml APHA pipettes to make a 1:1000 dilution by transferring 0.1 ml of a 1-100 dilution. When measured properly the 0.1 ml test portion is as accurate or more so than measurement of 1 ml to a 9 ml blank and after agitation transferring a 1 ml portion of such dilutions. In measuring the reliability of the plate count, it has been customary to calculate only the distribution or sampling error between replicate plates of a given dilution, and ignore the errors of pipetting involved in reaching the given dilution, on the assumption that the dilution error is small, constant and unimportant. Work done some time ago showed that the dilution error has about the same magnitude as the distribution error, and is equally deserving of consideration, especially since it increases with higher dilutions whereas the distribution error does not. The size of the dilution error may depend upon errors in the volume of the blanks, in reading or delivery of pipettes and the number of dilutions made. With the same percentage error allowed for 99 ml and for 9 ml blanks it is better to use 99 ml since fewer blanks are required to reach a given dilution.

The dilution error as percentage of standard deviation was approximately doubled when 9 ml blanks were used instead of 99.

In view of the importance of this detail and the general failure to interpret the directions in Standard Methods correctly, a diagram will be placed in the 11th edition to emphasize and clarify this point.

V. Averaging Counts

James R. Clark & Son
Theoretical comparisons indicate that the 3-out-of-4 method is considerably more stringent than the logarithmic average for grading bacterial quality of milk by plate count. A less strict 3-out-of-5 rule would agree more closely with log-average methods, but in theory would still yield a higher proportion of unfavorable reports. Detailed analysis of 469 series of actual plate counts representing milksheds from almost every region in the country clearly confirmed the theoretical comparison of the log-average and 3-out-of-4 methods and showed that in practice the 3-out-of-5 rule yields about the same proportions of violations and degradings as the log-average. These findings held for a grade limit of 100,000 as well as 200,000 colonies per ml. It may be of interest that the studies showed wide, roughly periodic fluctuations in plate counts often occurred. Such variations did not appear to be related to seasons of the year and probably reflect a change in conditions on the farms.

The Reference Committee on Microscopic and Reduction Methods has entirely rewritten Chapter 4 on Direct Microscopic Method and Chapter 5 on the Dye Reduction Methods. The polychrome methylene blue stains in the 10th edition will be deleted and replaced by the Levowitz-Weber modification of the Newman-Lampert stain for direct microscopic counts. Application of the direct microscopic method to non-fat dry milk solids has emphasized the importance of adequate illumination as well as proper stains in enumerating bacteria by this procedure. Accordingly the 11th edition stipulates use of a microscope lamp, preferably research type, equivalent to at least 100 watts illumination and a reflector, condensing system and iris diaphragm. Kohler type or critical illumination gives best results. In past years some difficulties have been reported with the mechanical syringe described in the 10th edition, in that some instruments yielded dark metallic deposits which were confusing in direct microscopic preparations.

Several changes in materials and methods used in assembly of the syringes were tried by the manufacturer and apparently recent models are free from the difficulty noted.

Little change has been made in the dye reduction tests regrouped in Chapter 5. While it is true that there is a general relationship between the standard plate count and reduction time it is also true that there are always substantial differences. As with the direct microscopic method, areas which have changed to bulk farm tanks and mechanical refrigeration are reporting that these tests are less useful than in the past.

Chapter 6 on Coliforms has also been entirely rewritten and rearranged. The general experience as well as practice in applying coliform determinations to milk and milk products has been that solid media yields the maximum amount of information with the least amount of materials and labor. This has been verified recently in an experimental and theoretical comparison of the reliability of coliform density tests in connection with water analysis. A substantial mathematical bias in MPN values relative to plate counts was experimentally demonstrated, the magnitude depending on methods of analysis to which MPN data are submitted. The precision of plate counts in the range of coliform densities investigated was found to be at least three times as great as that of replicate 5-5-5 tube MPN numbers.

Since organisms other than coliform may ferment formate ricinoleate broth to yield gas production, this medium will be deleted in the 11th edition, leaving two solid media and brilliant green bile broth. An effort was made to clarify the discussion on MPN's on either 1 ml or 100 ml basis. Provision is made for optional incubation of coliforms at 32°C, as well as at 35°C.

The scattered material in the 10th edition on Thermoduric and Thermophilic Bacteria has been brought together in Chapter 7. There has been no essential change in procedures except that material on psychrophilic bacteria has been added. Tentatively this will stipulate incubation at 7°C for 10 days rather than the other alternatives commonly used such as 5°C or 10°C.

The Reference Committee on Detection of Pathogens has grouped together in Chapter 8 the material on pathogens previously scattered throughout Standard Methods, has brought these methods up to date and has entirely re-written and rearranged their organization.

Bringing this material together elicited a number of comments and undoubtedly will result in an improved presentation in the 11th edition. New material has been added on staphylococcus, streptococcus and Q fever. Since bovine infections with the rickettsia, Coxiella burnetti, apparently occur in all parts of the United States, methods are given for their detection in milks. The capillary tube agglutination test is the method of choice for testing milk specimens and is ideally suited for rapid screening of cow's milk or pooled milks of entire herds.

Chapter 9 on Miscellaneous Microbiological Methods has been organized to include certain procedures formerly listed under screening tests such as the Burri slant method and tests for antibiotics. Consideration was given to inclusion of the membrane filter and the reference committee concerned sponsored comparative studies in several laboratories for two successive years. In spite of the attempts to improve the Millipore filter directions in 1958, a wide disagreement still occurred between determinations in different laboratories, the causes for which were exceedingly difficult to identify. It was hoped at least once during 1958 that someone would be able to observe the making of tests in each laboratory to suggest steps to correct some of the causes for the disagreements. It is conceivable that the bacterial flora of the milk in the one area supplying a city of more than 3,000,000 inhabitants and having the better agreement between methods differs from that in each of the other five areas. However, it is more likely that where the director of the laboratory has first-hand knowledge of the MF method for tests on water supplies that he use this knowledge to better advantage on milk samples, and therefore the comparative tests agreed better. Until better agreement can be obtained between the conventional and the membrane filter method, it is unwise to recommend the use of the latter as an optional substitute. Its use is, however, permitted for examination of water rinses from milk lines in Chapter 16, concerned with sanitization of containers and equipment.

Two simplified viable count methods have been studied as possible substitutes for direct microscopic counts, dye reduction tests and agar plate counts in grading low count raw milk resulting from more general usage of mechanical refrigeration and farm bulk tanks. One is a modified Frost little plate consisting of spreading mixtures of 0.01 ml of milk and 0.02 ml of agar over circular 1 sq cm areas on milk slides and incubating in a moist chamber at 35° C for 12 to 20 hours. The little plates are dried, stained, and counted using 100X magnification. Statistical analysis of preliminary data from a significant

number of samples indicated no appreciable difference between little plate and standard plate counts.

The second simplified method consists of transferring with a platinum loop 0.001 ml of milk to an oval tube containing 3 to 4 ml of melted agar, mixing, laying the tube flat until the agar solidifies, incubating at 35°C. for 48 hours and counting the resulting colonies using a Quebec colony counter. In a series of three experiments in which 39 samples were examined, the oval tube count of 23 was within 20% of the standard plate count; 10 were lower and 6 were higher by more than 20%. In this series, the little plate counts were adversely influenced by excessive drying or other unfavorable conditions. Even so 18 were within 20% of the standard plate count although 16 were lower and 6 were higher by more than 20%.

Similarly the Reference Committee on Butter, Cheese and Cultured Milk has grouped together the material on milk products formerly appearing under Frozen Dessert Ingredients, and has added new material in Chapter 10 on Concentrated, Flavored, and Cultured Milks. Previous editions of Standard Methods have not contained any information on laboratory examination of cultured milks which have been used from ancient times but until the last half century were largely hit and miss operations. They are now controlled operations in most dairy plants, and methods have been included for buttermilk, sour cream, yogurt, and acidophilus in which yeast and molds or coliforms are objectionable. Standards suggested are not to exceed 10 per ml for yeast and molds and not more than 10 coliforms per ml in more than one of the last four samples. Chapter 11 on butter will have added a proteolytic count and test for coliforms, using for proteolysis the current USDA procedure which calls for the addition of 10% skim milk to the medium, and, after incubation at 21°C. for 48 hours, recording the count if low; or, if the counts are high, the plates may be left and read after 72 hours incubation. The proposed standard for this is not more than 50 per gram of butter. Chapter 12 on cheese will have added procedures and standards for the examination of cottage cheese.

The Reference Committee on Frozen Desserts has revised Chapter 13 on Ingredients of Frozen Desserts to delete the milk products and retain other products such as coloring and flavoring materials, sweetening agents, eggs and egg products, and stabilizers.

Chapter 14 on Frozen Dairy Foods has been revised but without any major changes.

The Reference Committee on Sediment Tests has prepared Chapter 15 with extensive revisions to include sediment tests of bulk farm tanks, and off the bottom samples, using several of the various volumes that have been suggested. For example, the original sediment discs although measuring 1 1/4" diameter actually have 1/8" of this covered by the rim so that only 1 1/8" diameter is actually used for filtration. This has resulted in improperly computing equivalent areas, and the 0.44" orifice used in some areas should actually be 0.40" so that the test would be based completely on a one-gallon formula. Difficulties have been experienced in suitable standards for fine sediment, and this and other details will have specifications in greater detail than previously.

The Reference Committee on Sanitization of Equipment, Air, and Water Supplies has in Chapter 16 reviewed and revised the material on sanitization appearing in the 10th edition. Minor changes have been made such as optional use of soluble alginate swabs in place of cotton, and providing that where large quantities are needed to adapt rinsing procedures to dairying equipment, large quantities of tap water may be rendered practically sterile by treating with 25 ppm of chlorine for 10 minutes followed by neutralization with 10% sodium thiosulphate. Although the membrane filter has been found unsuitable for total counts, coliform, or microorganisms in air, it can be used to advantage in filtering large quantities of sterile water used to rinse cleaned-in-place pipe lines, sanitized cans or other containers. Accordingly its use as described in this chapter is limited to rinse water, although it may also be used in the bacteriological examination of water samples since it will be given as an official method in the 11th edition of Standard Methods for the Examination of Water, Sewage, and Industrial Wastes.

VI. Air Supplies

A new chapter is being prepared by this Reference Committee on Sanitization of Plant Air and Water Supplies. This has been necessitated by a lack of appropriate methods for bacteriological examinations. In 1955 the New York State Association of Milk Sanitarians addressed a letter to the APHA stating that the use of atmospheric air, water vapor and other gases by direct incorporation and indirectly by application to containers and equipment in the processing of milk and milk products is becoming increasingly more prevalent. They recognized the possibility of contamination

and recommended that the APHA review this problem with consideration to a standard of air quality, laboratory methods and techniques for measurement thereof. This has assumed greater importance with the trend to use of air under pressure for agitation of milk and the movement of milk and milk products, as well as the common incorporation of air in ice cream, its use to automatically open paper containers for ice cream novelties, etc.

Although it may be difficult to illustrate any public health hazard, nevertheless clean air should be used for processing in the dairy industry. Accordingly it seemed appropriate for the Standard Methods committee to review the equipment and techniques currently available for determining the microbic content of air and include procedures which appear suitable. Recommended methods to establish a reliable laboratory analysis need not necessarily be delayed until public health significance has been demonstrated.

Methods will be included which should be adequate for use by either health officials or industry. The present edition of Standard Methods does have a microbic density for air in laboratories of not more than 15 colonies falling in an open agar plate during 15 minutes exposure. This was originally a limit used in some dairy processing plants for permissible number of bacteria in rooms used for processing cottage cheese. Such criteria may be utilized in determining whether process rooms are sufficiently isolated and free from traffic, for example, in order to determine whether or not covers may be necessary on cheese vats. Other methods may be needed to determine the suitability of air in storage rooms where milk products are kept for long periods of time, and for pressurized air direct from compressors or in pipe lines.

VII. Water Supplies

Although potable water supplies are required in the production of Grade A milk and in the operation of milk plants, these may be checked infrequently and are subject to the usual failures of materials, machines and men. Furthermore, water of suitable sanitary quality may contain low numbers of psychrophilic bacteria which grow under prolonged refrigeration during storage of milk and milk products and may result in off-flavors, odors or deterioration of manufactured products with which it comes in intimate contact as in rinsing butter and cottage cheese. Water is also frequently

used in reconstituting condensed or powdered milk which may not be repasteurized. Due to the nature of the fermentations that they may cause the type of organisms are much more important than total numbers. Thus the bacteriological condition of the water supply is extremely important in dairy plant operations, especially if it comes in direct contact with plant equipment and some dairy products. Recent data showed the importance of water as a source of organisms which may cause spoilage in dairy products and emphasized the ineffectiveness of coliform determination as an index of desirability of water for dairy plant use.

Generally chlorination has been used to control water-borne spoilage organisms but the water should be held sufficient time to insure adequate contact. In some instances pasteurization has been used as a means of rendering contaminated water supplies suitable for milk plant use. Most of the water samples from 14 butter and 12 cottage cheese plants were free from coliform bacteria but contained psychrophilic, protolytic and lipolytic organisms. Only four of 26 samples met standards of a maximum total count of 50 organisms per ml and a maximum of 5 protolytic and/or lipolytic organisms per ml. Water samples taken at or near the source where the water had entered the plant contained fewer bacteria than samples taken at the churn door or cheese vat, suggesting contamination of lines within the individual plants. Open pipelines found near cheese vats or churns could be terminated with a section of sanitary pipe and cap which could be readily disconnected and sanitized.

VIII. Chemical Analyses

The Reference Committee on Chemical Methods is responsible for preparing Chapter 18 on Miscellaneous Chemical Methods, Chapter 19 on Phosphatase Methods, and Chapter 20 on AOAC Chemical Methods which are taken directly from the Manual of Methods of that Association. In addition to the miscellaneous chemical methods now included under screening tests in the 10th edition of Standard Methods, the 11th edition will contain methods for the radiochemical analysis of milks suitable for use by State and local health departments for surveillance purposes. Methods will be available for Strontium-90 and one or more of the short half-lived radionuclides such as Iodine-131, Strontium-89, or Barium-140. The latter group will be included primarily for purposes of monitoring nuclear energy installations.

In this country in 1890, Dr. Babcock substituted sulphuric for

hydrochloric acid to develop a procedure for butterfat testing which has since been known as the Babcock test. In that same year Dr. Gerber in Switzerland developed a single, simple test requiring less than 1 minute per sample and a single centrifuging which recovers fat to within 0.05% of solvent extraction tests, and is suitable for regular and homogenized milks and their blends, as well as skim milk, buttermilk, sweet and flavored milks and drinks, and yogurt. Since then the Gerber test has been preferred all over the world except in the United States where the Babcock test has been the official method. The Gerber test has, however, been used officially by three States in this country, New York, New Jersey and California. Sixty years of world-wide data, including American, substantiates the efficiency and accuracy of the Gerber test just as research has established that the Babcock test, although official in the United States, is inadequate for use on homogenized products. Since pasteurized milks frequently contain variable portions of homogenized globules especially when left-over homogenized milk is blended with cream-line and packaged in paper containers, there have been differences in results reported by different laboratories. Accordingly, it is planned to include the Gerber procedure in the next edition of Standard Methods.

Watering of milk appears to be prevalent throughout the country, and more and more official as well as industry laboratories are giving added attention to this problem. In the past accurate determinations of added water were laborious, time consuming and consequently expensive, but recently equipment has become available based on the use of thermistors instead of thermometers for the freezing point measurements required. Since a thermistor is quite small, its entire mass is influenced by the temperature of the medium immediately around it. This permits the use of small 2 ml samples whose temperatures are readily kept uniform, and thus the reading at freezing remains constant for a comparatively long period and the values plot into a straight line instead of into a curve as in the present Hortvet Cryoscope procedure (which is influenced by the comparatively large amount of mercury in the thermometer bulb utilized). In new equipment complete with a refrigeration system, automatic agitation, and automatic controls, it becomes a simple matter to make a determination at the assumed freezing point within a minute or so, and to reset the dial and rerun the sample since the contents have not been diluted by the addition of an ice crystal as may be done in the present procedure. Although comparatively expensive, the new equipment has so many advantages that this procedure also will be included in the 11th edition of Standard Methods.

The last chapter will consist of Chemical Methods compiled by the Committee on Editing Methods of Analysis of the Association of Official Agricultural Chemists, and approved for publication by that Association, including current changes to date that are approved at annual meetings.

IX. Phosphatase Test

Surveys have shown that in carrying out phosphatase tests apparatus requirements are usually in compliance except for lack of a proper light filter. The common deviation in preparation of materials is failure to neutralize the butyl alcohol. This may result in off-color tests and reporting positive results as negative. The other common deviation is failure to prepare a properly diluted positive control. In carrying out the technique there are frequent deviations in length of incubation time, failure to incubate the required time, not extracting the field test with butyl alcohol, not extracting by the technique stipulated, and not repeating the extraction and separation steps. The most common deviation is failing to read the extracted tests and record in units or preferably as micrograms of phenol per ml.

Until recently many laboratories have not had a 1 unit standard and in some instances their standards were obsolete in that they were not based on the present copper-containing reagent. In some instances phenol standards were used, but were not extracted for the field test and diluted with butyl alcohol as required. One of the principal difficulties in reading tests seems to be inadequate illumination with errors compounded by the prevailing use of green, blue or yellow colors on laboratory walls. Many laboratories routinely do not use standards but base their interpretation on the original statement in Standard Methods that any blue color indicates underpasteurization. This requires the observer to decide whether a color is or is not blue, and may result in wide differences. Accordingly it seems desirable in the next edition of Standard Methods to require that this chemical test be read and recorded in terms of units or micrograms of phenol per ml and stipulate that reading shall be done under proper uniform illumination. It has been determined that a single 14-watt daylight type fluorescent bulb as used in a dental X-ray film viewer provides optimum illumination. This is comparable to reading tests in a room free from color near the window upon a sunlit morning, while using a new plastic light filter screen behind the tube as now

stipulated for the modified technique in Standard Methods. Thus the requirement is not different, but only assures that there will be optimum lighting under any and all environmental conditions that may be present in a laboratory.

X. Appendices

The formulae for all Culture Media mentioned in the several chapters, and directions for making and using media, will be included in Appendix A, listed alphabetically and numbered for appropriate reference. Similarly Stains will be listed in Appendix B; Reagents and Indicators in Appendix C; detailed Specifications for Chemical Glassware, principally for butterfat, in Appendix D; and, for easy reference and to insure that controls are not overlooked, Appendix E will list all bacteriological controls and checks appearing anywhere in the twenty chapters comprising the 11th edition.

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PROCEDURES FOR CONDUCTING SURVEYS OF MILK CONTROL LABORATORIES--CERTIFICATION REQUISITES

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I. Laboratory Approval

1. Pioneer Activities

- a. The preceding discussions have reviewed the program in this country for certification of Grade A market milk. There is also a program for certification of milk laboratories, pioneered years ago by Connecticut and New York. During surveys in 1941-43 of official milk laboratories in war areas many deviations from Standard Methods were observed. For example, out of 168 sub-items on the Agar Plate Count, the average number of deviations per laboratory varied from a minimum of 13 in the two States having an approval system for local laboratories, to a maximum of 47.5 in other States. ⁽¹⁾
- b. It may be of interest to recall that serological tests were first evaluated nation-wide in 1937 and since then most States have undertaken programs of approval for serological tests. A number of States have had similar programs for checking medical laboratories, and the deviations in diagnostic procedures reported were just as common as in sanitary bacteriology. More recently Connecticut has reported on its evaluation of local water laboratories. ⁽²⁾
- c. A few cities have undertaken approval of milk laboratories; for example, some years ago Boston approved city laboratories, and recently milk control officials in Louisville, Kentucky, published their experiences in the approval of of dairy industry laboratories. ⁽³⁾

2. Efforts To Increase Conformance

- a. The APHA committees responsible for revisions of Standard

Methods have endeavored to clarify meanings and supply uniform directions. In the 1948 edition, Chapter 2 pertaining to sampling and the principal bacteriological methods was reprinted as a separate, and a subcommittee condensed this even further in mimeographed form for sale to students.

- b. The survey forms for milk laboratories based on Standard Methods are also useful as training aids and guidelines to workers.

3. Recent Progress

a. Standard Plate counts:

- (1) The comparative study of plating agars sponsored by the Applied Laboratory Methods Committee of the IAMFS⁽⁴⁾ demonstrated that laboratories adhering closely to Standard Methods requirements had more reliable plate counts.
- (2) Other studies⁽⁵⁾ have emphasized the role of individual workers and effective supervision in attaining maximum accuracy.

b. Variability in Direct Microscopic Counts

- (1) Mechanical operations such as pipetting, smearing, drying, etc., are potential sources of variation among replicate films from a single milk sample. However, human factors producing differences among individual observers in their ability to distinguish between bacteria and debris, or in general alertness, experience, training, etc., have been found to be by far the largest source of variation between D. M. C. 's. Therefore, the human error needs to be evaluated in each laboratory. ⁽⁶⁾ This evaluation may indicate the need for further training.

4. Pertinent Recommendations

- a. In 1948 the Conference of State and Provincial Public Health Laboratory Directors sent out a questionnaire on evaluation of laboratories to all State Health Departments. Thirteen reported they evaluated sanitation laboratories; 14 replied they did not. Only 8 approved laboratories for water, milk, or other foods, and 7 replied they did not approve them.

- b. In 1950 the Engineering Section of the APHA⁽⁷⁾ sent out a questionnaire on certification of laboratories performing bacteriological work on milk. They had replies from 44 States; 3 of these had a mandatory certification, 4 had a voluntary plan, 2 certified for premium payment, 5 certified for official work, and 1 certified contract laboratories doing official work. Eight States did not favor certification, and 6 States expressed no opinion in 1950, but by 1958, 13 of these 14 were approving milk laboratories, which shows the progress that has been made since the first Conference on Interstate Milk Shipments held in 1950.
- c. The National Conference on Interstate Milk Shipments⁽⁸⁾ stipulated that laboratories utilized for interstate shipment of milk must follow APHA Standard Methods and that local laboratories could be utilized provided State officials visited them annually and evaluated the quarters, equipment, procedures, results, and records on appropriate survey forms of the Public Health Service or equivalent and provided they checked closely at least twice a year on split samples. To insure uniformity the Public Health Service was to spot check the laboratories of State agencies. These requirements have been in effect since the first conference in 1950, although in subsequent Conferences some additions have been made. For example the requirements were applied to dairy products as well as market milk, and the collection of samples from farm tanks by licensed samplers and the acceptance of industry sampling were recommended.

5. Present State Activities in Laboratory Approval

- a. In making surveys most States have utilized survey forms developed by the Public Health Service based on Standard Methods. These have been revised each time there is a new edition of Standard Methods. In some instances States have permitted only one of the alternatives provided in Standard Methods, for example, designated one solid coliform medium, or one stain for direct microscopic counts, etc.
- b. In 1942 only two States, Connecticut and New York, had approval programs for milk laboratories. By the time of

the first National Conference on Interstate Milk Shipments in 1950, 12 States had approval programs, (9) and at that time two States submitted to the Public Health Service completed survey forms on local milk laboratories. Approval of laboratories increased slowly until 1954, at which time a terminal date was set after which States not having approval programs for local laboratories would no longer be included on the published list of interstate milk shippers. At the present time there are only 6 States that have not participated in interstate milk shipment. Survey forms for local laboratories have been received from 38 interstate milk shipping States. About 1955 split sample reports started to increase, and the establishment of a terminal date of July 1, 1958, for split sample programs has resulted in receipt of such results from 36 States.

- c. As of January 1959, 42 States reported approval of 800 milk laboratories, consisting of 515 official, 86 private, and 199 industry. At present there are 35 interstate milk shipping States utilizing 354 local laboratories. As of January 1, 1959, these 35 States together with two States previously listed (reporting 14 laboratories) and three States not yet listed as interstate shippers (reporting 18 laboratories actually used for interstate milk shipment) reported that 231 official, 32 private and 123 industry laboratories were utilized. These 40 States had approved 295 laboratories for agar plate counts, 289 for coliform, and 270 for phosphatase tests. For raw milk 243 laboratories were approved for plate counts, 127 for direct microscopic counts, 45 for methylene blue, and none for resazurin reduction tests. Actually fewer direct microscopic counts and reduction tests are being utilized for interstate milk shipment, and more laboratories are using agar plate counts.
- d. Of the 40 above States 37, plus at least 3 others not now having milk laboratories used for interstate shipment, have split milk samples for plate counts, coliform, and phosphatase tests on pasteurized milk. At least 34 had used split cream samples or had other milk products. Thirty, 14, and 5 respectively had split raw milk for plate counts, direct counts, or methylene blue reduction tests.

- e. Twenty-eight States were shipping liquid split samples, 10 frozen samples, and 3 or 4 regularly or occasionally split samples at the time the laboratory was visited to make the survey.
- f. A committee of the Laboratory Section of the APHA on Evaluation of Performance sent questionnaires to 62 State and Territorial laboratory directors in 1958. Almost all (95%) of the 52 replying felt that formal evaluation of technical performance of laboratory personnel by means of check specimens should be a function of the State laboratory. Actually 44 out of 52 replying were so engaged in at least one technical field; for example, 39 in serologic testing for syphilis, 27 in milk testing, 16 in bacteriology, 13 parasitology, 10 water examinations, 5 mycology, 4 clinical chemistry, etc. It was concluded that the enthusiastic response and constructive comments indicated a growing awareness of the responsibility of the State laboratory in assisting local laboratories by means of evaluation techniques to maintain accurate dependable results.

6. Percentage Rating

- a. Occasionally it has been suggested that a numerical rating should be applied to laboratory surveys. For example, in 1958 the laboratory survey officers of Public Health Service Region III recommended "A point system of rating laboratories would be valuable, with a definite score needed for compliance rather than relying on the 'substantially in compliance' now used." The Georgia Department of Public Health for some years has enumerated the different items checked on the laboratory survey form, and from this reported a rating in percentage.
- b. Others believe individual grading of all items might permit some very serious defect to be hidden in an otherwise passable score. As an extreme example a laboratory might have a zero rating on suitability or temperature of the sample, but be rated high on fulfillment of all other requirements. Such a score indicating an almost perfect value might be far from the truth if the results were of little or no value.

7. Time Studies and Costs of Laboratory Analyses

- a. Time Equivalents for technical public health laboratory procedures have been used in the Bureau of Bacteriology of the Maryland State Department of Health for a number of years. These have been useful when requesting extra positions because they afford tangible evidence to fiscal authorities and administrators of the need for additional personnel. Their purpose, however, has been twofold; firstly, to get reasonable assurance that laboratory workers are not being required to do more work than they have time to do properly, and secondly to determine that the public is receiving a full measure of service for their tax dollar. Dr. Perry reported in 1950⁽¹⁰⁾ that the time equivalents had been refined to the point where they were reasonably accurate in most instances. They represent the time in minutes required to do actual technical work concerned with any laboratory examination and to record the results. They do not include time to prepare media, solutions or reagents, to prepare reports or any other incidental work. The values represented a comfortable working speed so that it is possible to do more than a 100% load of work, but it is not considered desirable to have laboratory workers constantly working under such overloads.
- b. There is, of course, a direct relationship of time to cost; and since other costs are known, the relationship of the time equivalents to the total cost of operation can be determined. The average cost per minute for technical and non-technical time can also be closely approximated. In 1949 the over-all total cost per minute in Maryland was 10.8 cents with plate counts of milk and cream requiring 15 minutes, microscopic counts 5 minutes, phosphatase tests 10 minutes, butterfat tests 12 minutes, etc.
- c. In fiscal year 1952-53 the Washington State Department of Health⁽¹¹⁾ reported that milk examinations cost a little over \$.99 cents for examination and with an administrative cost of \$.57 gave a total cost for examination of \$1.56.
- d. The Chief, Public Health Laboratory, San Diego Department of Public Health, determined times and costs for 1954-55 and 1955-56 fiscal years. Plate counts required 16 minutes and

cost \$1.05 and \$1.11 respectively, coliforms required 20 minutes costing \$1.32 and \$1.39, phosphatase tests 5 minutes at a cost of \$.33 and \$.35 and butterfat tests 15 minutes at a cost of \$.98 and \$1.04. Figures from three other public health laboratories in California showed that plate counts cost \$.90, \$1.50 and \$.92 respectively, phosphatase \$.51 and \$.31, and butterfat \$.90, \$1.52 and \$.92 respectively. Two commercial laboratories charged \$.70 and \$.75 for plate counts and \$.75 and \$2.00 respectively for phosphatase tests.

- e. He later ⁽¹²⁾ worked out for his laboratory a series of laboratory work units which, in addition to things actually measurable, made allowances for certain intangibles which must be estimated such as supervision, training, public relations and interdepartmental responsibilities. Since the largest part of the most of laboratory tests is the personnel time involved, one requiring twice the time of an average test could accurately be considered to cost twice as much as the average. Once costs have been obtained, they can be used to determine how much it costs to examine a given product, to bill other jurisdictions for the cost of examinations, to determine the cost of a milk control program so the amount raised by fees will make this self-sustaining, to determine prior to adoption the cost of a new program by using a preliminary estimated work unit, and to accomplish performance budgeting by assigning costs of all laboratory examinations to the bureaus and divisions requiring such services.
- f. In recent years a good deal of emphasis has been put on performance budgeting whereby service bureaus such as a laboratory are not given a budget of their own but the money to provide the necessary laboratory services is allocated by the bureau responsible for the program. It has been indicated ⁽¹¹⁾ that this does not detract from the identity of the laboratory in the over-all organization plan and does result in inclusion of the laboratory director in the department planning to a greater extent. This was intended to overcome the tendency for directors of other programs to take laboratory services for granted without knowing much about what such services cost or required in the way of personnel or facilities. When legislative committees ask for detailed information as to cost of specific services, such performance budgets furnish answers to such questions clearly and quickly.

- g. With the establishment of the emergency medical service in England during the last world war, a "schedule of unit values" for laboratory procedures was developed in 1943, modified in 1944 and again in 1947. (13) This was based originally on a unit value of six minutes, that is 10 units per man hour. It was further revised in 1952 and the unit value changed to 10 minutes, that is 6 units per man hour. During the last ten years several separate groups of medical laboratories in Canada have attempted to apply unit measures to record workloads, all of which are linked closely to technical time required for the performance of various laboratory procedures. Generally, the Canadian times compared closely with those reported by Maryland. Canadians have concluded that scoring of laboratory functions is a must to conserve scientific effort and to determine and make use of only those methods which are most practical and rewarding.

8. Administrative Practices

- a. Evaluation indices were designed by the New Jersey State Department of Health to provide a quantitative and qualitative appraisal of activities under the objectives peculiar to their program and were prepared primarily for the Program Coordinators' own use. Quantitative measures were volume of work performed each fiscal year in terms of specimens examined and tests completed for routine and special bacteriological tests. Quantitative appraisal of inspection and evaluation of other bacteriological laboratories were in terms of numbers of public, private and hospital bacteriological laboratories evaluated that were seeking approval; inspected and re-evaluated as approved laboratories; as performing special investigations; or as supervised State branch laboratories.
- b. Qualitative evaluation was based on an index developed to serve as a guide for appraisal, its fundamental requirements based on standards for laboratories as set forth in the State sanitary code. The code sets forth certain minimum requirements which must be adequate in the laboratory appraisal or the laboratory is automatically unsatisfactory. Such categories are indicated in the index by the use of asterisks or an "Ex", denoting exception, preceding the item or element. The

construction of the index was meant to exhibit sufficient flexibility to be applicable to any public health bacteriological laboratory, State or local level.

- c. Asterisks were used in those items or elements which must receive a satisfactory rating on an individual basis in order for the laboratory to receive a satisfactory score. This basic score has been set at 70 and if all items so marked with an asterisk are found acceptable, the laboratory then receives a basic score of 70. To this score is added a total of supplemental numerical values assigned to other items to determine the total numerical evaluation of the laboratory.

9. Administrative Trends

Recently attention has been given to simplified administrative control of milk, looking toward use of newer techniques which may reduce cost and simplify control. All official agencies are faced with ever increasing needs for new programs to meet changing conditions, and there is a definite trend to use approved industry laboratories. The next president of the American Dairy Science Association⁽¹⁴⁾ believes that the effectiveness of the existing inspection force and laboratory facilities of health agencies could be greatly extended by requiring dealers to provide laboratory and inspection service for all producers and plants, possibly including licensing of these inspectors and laboratories; by devoting a judicious percentage of their effort to the supervision and training of licensed technicians, farm and plant inspectors, followed by spot checking of the effectiveness of their work; and by a systematic review of the company laboratory procedures and laboratory reports of receipts of raw milk and their analyses of finished products, together with spot checks of the results in the health department laboratories.

II. Public Health Service Milk Laboratory Evaluations

1. Forms (free upon request)

Survey Forms for Milk Laboratories are free upon request to Public Health Service Regional Offices or to the Sanitary Engineering Center. In making surveys, items that are correct are left blank, although it is convenient to check off

such items in the marginal number, as a reminder to the survey officer that he has completed that item.

2. Keyed Recommendations (uniform for common errors)

Keyed recommendation sheets were developed by Public Health Service laboratory survey officials for their own use in making uniform reports. These have been distributed to all State milk laboratory certifying officials to encourage uniformity in the manner in which surveys of local laboratories are reported.

3. Narrative Reports

Major deviations noted in surveys should be commented on in writing. Usually such a statement would consist of a recommendation of what should be done to remedy or correct the deviation.

4. Spot Checks

The original proposal for federal participation in interstate milk certification in 1946 provided for regional offices to spot check the work of State sanitarians and rating methods, and for the Sanitary Engineering Center to do similar spot checking on laboratory procedures. At that time it was stated that although inspections by local authorities may not be used for rating purposes, the State may accept reports from local official laboratories that have been approved as complying substantially with APHA Standard Methods and as checking within 10% on results obtained at least twice a year on split samples. We have delayed using that or other criteria on how closely laboratories should agree, pending completion of current statistical studies.

5. Split Samples

In addition to making periodic visits and surveys of local laboratories, both of the States pioneering in milk laboratory evaluations checked the bacteriological work of local laboratories by analyses of split milk samples. To the best of our knowledge the origin of their evaluations utilizing split samples is unpublished, but presumably they recognized a need in approval programs for tangible evidence that

laboratories were making analyses correctly, and split samples provided a means for checking this. A procedure of splitting milk samples for agar plate counts and direct microscopic examinations by several analysts in different locations was utilized with satisfactory results forty years ago as reported by the late R. S. Breed. (15)

- b. During World War II, when the Public Health Service had a number of mobile laboratories assigned to various States, milk samples were sometimes split with local laboratories to promote uniformity in analysis. In recent years we have participated in several evaluations of phosphatase procedures based on split samples, and in several evaluations of direct microscopic examinations. In the past few years containers and facilities for shipping out split samples have been developed. (16) In April 1958 when the Association of State Laboratory Directors met in Cincinnati, a report was made to them on samples split with all of the State health agencies being certified for interstate milk shipment. After statistical analysis of these first surveys and establishment of statistically sound criteria as to limits which should be acceptable, compliance should be expected. Data on the results of split samples are coded and returned to States participating.

III. State Certification of Local and Branch Laboratories

1. Surveys

- a. There are over 50 individuals in 40 States who have been listed as milk laboratory certifying officials. Most of them have attended one of the SEC training courses. At the last National Conference on Interstate Milk Shipments one of the resolutions adopted requested that the Center hold special seminars and training courses for laboratory survey officers at periodic intervals.
- b. On the interstate milk shipper report form distributed, (PHS-1659), item 3 on "Laboratory Control" calls for the name and address of the approved laboratory, tests for which approved, and date last checked by State.
- c. The original rules of the National Conference called for surveys annually and split samples each 6 months. However, this did not specify how many samples should be split.

Some States had not checked on coliform tests or phosphatase, many had not split raw milk samples, many had not included any dairy products, and some results submitted by States were based only on market pasteurized milk, generally with counts of less than 3,000 per ml, with low or no coliform colonies, and with negative phosphatase tests. Other States had carried out more comprehensive programs, and believed it was no longer necessary to make annual visits.

- d. The standing Laboratory Committee of the NCIMS considered these facts and recommended that if a State wished to reduce the frequency of visits this could be done provided their split sampling program included a minimum number of samples covering all methods actually used, all types of products certified (on Form PHS-1659) including a normal range of results as well as high and low counts and some samples positive on coliform and phosphatase tests, with some replicates under another number. These recommendations were reviewed by a task committee, presented to the National Conference, and passed in April 1957 and later published.⁽⁹⁾ Other recommendations provided for optional biennial surveys, for a minimum split sample program, provided that if a laboratory is deemed incompetent for some reason and the State no longer certifies it, the appropriate PHS Regional Office should be advised, etc.

2. Preparation and Transmission, Laboratory Survey Forms

- a. When the first page for any procedure is used (Survey Forms for Milk Laboratories, pages 1, 3, 7, 11, 13, or 19), include the name of the individual making the survey. Subsequent pages of such forms should be completely identified with the name of the laboratory, location and date (even when pages are stapled together).
- b. Forms pertaining to procedures not used should not be returned with the report. For example, a laboratory which does not use the "Direct Microscopic Count" should not have blank pages 7, 8, 9, and 10 of the Survey Form included with the report.

- c. When an entire section of an alternative method is not used, it should be marked "Not Used", since any unmarked item indicates it is used correctly in accordance with Standard Methods. For example, sections on Presumptive Test (Liquid Media) or Official Method II AOAC, may have the notation "Not Used" immediately following the section heading, or each numbered item in that section may be marked "O" (O = Not Used).

3. Narrative Report

- a. Every completed survey form should be accompanied by a narrative report giving the conclusions of the State laboratory certifying official as to whether the laboratory is doing acceptable work. By having a narrative report separate from the completed survey form, it is possible to submit only one completed survey form through the Public Health Service Region, provided two completed narrative reports are submitted so that one can be kept in the Public Health Service Regional Office. Accordingly the narrative report must identify the laboratory, show the date, who made the survey, what the recommendations were to correct any deviations, what tests were approved, and who was approved to do them.
- b. To make it easier for laboratory survey officers to complete a narrative report they may refer to the keyed recommendations for standard deviations. Items not covered by standard recommendations would be inserted as necessary. Certain other information should be indicated, those doing especially commendable work, the status of split samples, etc. Since laboratory survey officers may or may not themselves complete the Survey Form on Sampling, they may wish to comment on that or on any administrative problems in connection with interstate milk shipment.

4. Sampling Form

The Survey Form on Sampling (PHS 1500-1) should be completed annually or biennially for each Interstate Milk Shipment source. This may be done by either

State milk control officials (currently 20 are so doing) or their State milk laboratory certifying officials (currently 20 so doing).

5. Notification of Changes in Approval

It is recommended that in the event a local laboratory is deemed incompetent for such reasons as repeated failure to check closely on split samples, or loss of its only approved laboratory worker or director, or for some other reason is no longer approved by the State laboratory certifying officer, the State laboratory certifying agency shall immediately notify the appropriate Public Health Service Regional Office.

6. Reciprocity Between States

The NCIMS recommended that all States consider the matter of reciprocity for those laboratories that are approved by the laboratory certifying authority of any other State. Thirty-three States have reciprocity.

7. Approval Forms, Certificates

The NCIMS recommended that the State laboratory certifying agency issue a certificate to those laboratories that it has approved, which certificates shall be returnable upon expiration or revocation. According to data collected for the 1959 NCIMS, 14 States are issuing certificates or letters of approval.

8. Interstate Milk Shipment Lists

Individuals may obtain copies of the Sanitation Compliance Ratings of Interstate Milk Shippers listing all shippers, which comes out quarterly, but individual requests must be made in order to be placed on the mailing list.

9. Requests for Recertification

Through an arrangement between the Milk and Food Program and the Sanitary Engineering Center, technical

consultation on laboratory problems can be furnished to the States from SEC. In order that professional time and available funds may be expended most effectively, requests for assistance to SEC should be made as far in advance as possible.

- b. Public Health Service endorsement of State laboratory certification programs presumes that representatives of the Service keeps in fairly close touch with control practices of the States participating by reasonably frequent consultations with State personnel and check inspections. It is believed we cannot report adequately on the effectiveness of the procedures in use unless this type of contact is maintained.

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DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE

FORM APPROVED:
BUDGET BUREAU
NO.: 68-R664

Robert A. Taft Sanitary Engineering Center
4676 Columbia Parkway
Cincinnati 26, Ohio

REPORT OF
EVALUATION OF CENTRAL STATE MILK LABORATORIES BY SPLIT SAMPLE PROCEDURE

Laboratory _____ Place _____

As soon as samples are received in the laboratory the package should be opened, the temperature of the sample marked "control" taken with a PRECOOLED THERMOMETER (32° - 40° F) and recorded. The remaining samples should be refrigerated if not analyzed immediately. Samples are of a sufficient quantity to allow 4 analysts to make an independent examination by all the indicated methods (except where reduction tests are indicated).

Preferably examine samples between 12:00 noon and 4:00 PM (EST) omitting tests crossed out on report form. (See reverse side of sheet).

For Standard Plate Count, plate 1-100 and 1-1000 dilutions in duplicate and report colony count of each plate, the average number of colonies for duplicate plates, and the calculated standard plate count per ml of milk.

For Coliforms, plate 1.0 and 0.1 ml of undiluted milk and report number of colonies on each plate and the coliform colony count per ml of milk.

Report results of phosphatase test as Neg if negative and in micrograms (ug) of phenol/ml of milk if positive. When using the Scharer Laboratory Method and the phenol standards (Standard Methods, page 311) for comparison, convert units to ug phenol/ml of milk by multiplying by the factor 2.3. When using the Scharer Field Test and the extracted and diluted phenol standards (Standard Methods, page 312) or the Applied Research Institute standards (for the field test) no conversion factor is necessary and the results of the tests may be reported directly as ug phenol/ml of milk.

In reporting the results of Direct Microscopic counts give actual number of fields and total number of clumps counted, the average number of clumps per field, and the calculated direct microscopic count per ml of milk.

If Reduction tests are used, report results as described in Standard Methods 10th edition, pages 139-140.

After completing this report form with the requested data (see reverse side of sheet), it should be returned to above address, attention Chief, Milk Sanitation. Please return by ordinary parcel post all tubes or vials, re-freezant and the inner insulated container in the shipper in which they were received, using the enclosed franked label which bears our address.

Samples received _____ AM, PM, on _____ 19 _____

Temperature (as determined with thermometer precooled to 32-40° F) _____

Samples examined _____ AM, PM, on _____ 19 _____

STANDARD PLATE COUNT - COLIFORM COUNT - PHOSPHATASE TEST

SPC: Medium _____ Brand _____ Lot # _____ pH _____
 Coliform: Medium _____ Brand _____ Lot # _____ pH _____
 Sterility Controls: SPC Agar _____ Coliform _____ Dilution Water _____
 Incubation Temp: °C _____ 1st Day _____ 2nd Day _____ Analyst _____
 Phosphatase: Method _____ Standards _____ Units-range: _____ to _____
 Negative test criteria (0.0, <1.0, <2.0, etc.): _____ ug phenol/ml Analyst _____

Sample Number	Standard Plate Count			Coliform Count		Phosphatase	
	1:100	1:1000		Undil.	1:10		
	Cols/Plate	Avg	Cols/Plate	Avg	SPC/ml	Cols/Plate	Cols/ml ug phenol ml
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

DIRECT MICROSCOPIC COUNT - REDUCTION TEST

DMC: Stain _____ Microscopic Factor _____ Magnification _____
 Light: Make _____ Type _____ Watts _____ Analyst _____
 Reduction: Method _____ Analyst _____

Sample Number	Direct Microscopic Count			Reduction Time		
	Number of Fields	Number of Clumps	Average No. Clumps/Field	DMC/ml	Methylene Blue	Resazurin
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

FOREIGN SUBSTANCES IN MILK

L. L. Ramsey
Division of Food
Food and Drug Administration
U. S. Department of Health, Education, and Welfare
Washington, D. C.

Pure milk has always been one of the common objectives of the Food and Drug Administration and the various local public health agencies. Much of FDA's educational and regulatory activity in this area has been directed toward assuring clean milk, milk produced under sanitary conditions and free from contamination by bacteria and other filth. With the help of sediment tests, bacteria counts, local standards for barns and dairies, and educational programs, a great deal of improvement has been achieved. However, the job of assuring clean milk rather than milk "cleaned" by straining to remove only insoluble filth remains with us and by its very nature perhaps will always be with us.

Bacteria, flies, rodent hairs, extraneous dirt, manure, and other filth in milk might be considered contamination by foreign substances, but the foreign substances I wish to focus your attention on today are perhaps more subtle and of more recent origin. They could be referred to rather broadly as chemicals.

The problem of these foreign substances occurring in milk, as well as in our general food supply, arises from technological progress in the production, processing, and distribution of milk and other food. The Federal Food, Drug, and Cosmetic Act of 1938 was found to be inadequate for coping with this problem largely for two reasons: first, the administrative procedure for getting an official tolerance for a pesticide chemical found useful in, if not almost essential to, the production of a food crop was quite cumbersome; and secondly, an untested chemical could be used in or on food unless and until the Food and Drug Administration could prove that it was poisonous or deleterious. Since extensive long-term feeding experiments are often required to establish the harmfulness or safety of a new chemical, this placed a heavy burden upon the Government. Therefore, the Congress, in order adequately to protect the public health and to facilitate administrative procedure which

would permit the consumer to benefit by technological advancement, amended the Act in 1954 by adding section 408 (the Miller Amendment) dealing with pesticide residues on raw agricultural commodities; and in 1958 the Congress again amended the Act by adding section 409 dealing with food additives in both raw and processed food. Each of these amendments provides for limiting, where necessary, the amount of foreign substances which may find their way into our food either intentionally or incidentally; in other words, they provide for the establishment of safe tolerances for useful chemical substances.

Let us examine for a moment the potential sources of foreign substances in milk. Pesticide residues may be incurred in milk by the use of insecticides directly on the cow and even in the dairy barn, or by the use of dairy feed and forage containing pesticide residues. DDT is the notorious example with which you are all undoubtedly familiar. There are, of course, a host of others. Drug usage of such compounds as lindane for the treatment of mange and of penicillin for the treatment of mastitis may give rise to residues in milk. Foreign substances may also be added to milk through the leaching of various components of dairy processing equipment, utensils, milk cartons etc., or through the use of chemical sanitizing agents. In processing equipment, for example, many parts such as pump rotors which were formerly made of metal are now being replaced by plastics; and some plastics contain components which may migrate into milk. Certain plastics may soon be able to compete price-wise for the milk carton business. The question of migration of components of plastics used in direct contact with milk, with only an occasional exception, remains to be settled.

If milk in its production, processing, or distribution incurs any amount of a foreign substance, consideration must be given to the matter under the antibiotic or new drug provisions of the Act or under one of the above amendments. If the foreign substance were not a drug or pesticide and further were not generally recognized as safe, it would need to be considered under the Food Additives Amendment. Thus far, no food additives petition with respect to milk has been filed. However, this is not surprising because the Food Additives Amendment was enacted only last September (1958) and is not yet fully effective.

Under the pesticide amendment milk is classified as a raw agricultural commodity subject to the tolerance setting procedure. This fact made it necessary for FDA to re-examine its traditional policy that "there shall be no added poisons in milk." After due consideration FDA announced that if a tolerance proposed to cover the

residues in milk of a useful pesticide were shown to be safe, with emphasis on the showing of safety, such tolerance would be established through the regular tolerance procedure. Although pesticide petitions for tolerances for several pesticide residues in milk have been submitted, no finite tolerance for any residues in milk has been established.

In order to evaluate the future outlook for tolerances in milk, let's examine the salient points of the methoxychlor ruling, with which you may be familiar. The petitioner for the methoxychlor tolerance had supplied adequate data to show that under the proposed conditions of use of methoxychlor as a spray for the control of flies, the maximum residue which would occur in the milk was 0.25 ppm. The petitioner had also supplied the usual acute and chronic toxicity data considered necessary to demonstrate the safety of the residue in or on raw agricultural commodities. The FDA considered the evidence of safety in the petition as justifying a referral to an advisory committee. Under the pesticide amendment either the petitioner for a tolerance or the FDA upon its own initiative may call for an appraisal of the matter by a committee of the nation's top scientific experts. This committee was appointed by FDA from a panel nominated by the National Research Council. The Advisory Committee recommended that the petition be denied and FDA adopted the recommendation, setting the tolerance for methoxychlor residues in milk at zero. The Committee, in its particular concern for the very young and the sick, for whom milk may comprise the major portion of the diet, also recommended certain specific types of experimental evidence, in addition to that generally required for other foods, be furnished before a tolerance for residues in milk be deemed worthy of consideration. Among these were:

1. "Evidence on the influence of the chemical on the growth of newborn and pre-weanling infants of two warm-blooded species."
2. "Evidence on the effect of the chemical upon animals with liver injury, in view of the widespread practice in medicine of using milk diets for patients with ailments affecting the liver."

For those of you familiar with the practical limitations of animal experimentation, the difficulties likely to be encountered in adducing these facts will indeed appear formidable. Thus, it is quite obvious that the likelihood in the near future for tolerances covering pesticide residues in milk is not very great. It might require less effort for the industry and

agriculture to develop new effective pesticides which would not incur residues in milk.

How has FDA operated so as to protect milk from contamination by foreign substances? Under the Miller Amendment FDA has adopted the policy of not setting pesticide residue tolerances on forage or grain normally used for dairy feed if such feed will give rise to pesticide residues in the milk. The petitioner for a tolerance to afford practical agricultural usage of a pesticide on primary feeds such as alfalfa forage, corn fodder, and grain is required to furnish data showing whether residues come through into the milk. These data must be obtained by very sensitive and reliable methods, since no residue in milk sometimes may mean less than 0.05 ppm, or even less than 0.01 ppm, depending largely upon the toxicity of the pesticide. It is not usually considered adequate to examine the milk merely for the pesticide itself. There must also be a showing that no likely abnormal metabolite or degradation product is present. Often this may involve metabolism studies, the use of two or three independent analytical methods for analysis of the milk, and even the feeding of radioisotope-labeled compounds. Very few pesticides useful on forage have withstood the tests and thus received tolerances. Methoxychlor at 100 ppm and heptachlor at 0.1 ppm are the only chlorinated hydrocarbons enjoying a tolerance on a basic dairy forage such as alfalfa. In support of the petitions for these tolerances data were offered to show that methoxychlor and heptachlor may be ingested by a cow at levels very much in excess of the tolerances before a residue appears in the milk. With methoxychlor a feeding level of about 500 ppm is required to produce a residue in the milk, and with heptachlor about 15 ppm is the feeding level required. Hence, there is a considerable degree of latitude between the tolerance level established and the level which incurs a residue in milk. Incidentally, since heptachlor had been shown to be metabolized by the cow to heptachlor epoxide, residue data were required to show that none of the metabolite as well as none of the heptachlor per se would appear in the milk of cows being fed forage containing heptachlor at the proposed tolerance level of 0.1 ppm. We realize, of course, that combatting pests on forage crops is a major problem in agriculture, that the present tolerances are of limited value, but we are confident that given time and encouragement agricultural scientists will find an acceptable solution.

At present we are encountering some regulatory problems arising from the practice of feeding fruit by-products such as apple pomace and dried citrus peel. When apples bearing DDT residues at the legal tolerance level of 7 ppm are used in making juice, the DDT, being water-insoluble, is concentrated in the pomace at levels so high as to render it totally unfit for dairy feed. Furthermore, it is fit for feeding beef

animals only under controlled conditions which will permit a two to three-month preslaughter interval for the residue to dissipate to the legal tolerance level of 7 ppm in the fat of meat. This problem led to the publicized warning last fall that apple pomace from DDT-bearing apples is not under any circumstances suitable for dairy feed.

At present we have very little information on the persistence of various pesticide residues in dried citrus peel and pulp. Perhaps, because of the treatment this feed gets, the problem will not be as serious as with apple pomace. Certainly, it would appear to be more localized, but we have no information on the quantity of dried citrus peel in interstate commerce.

Under the administrative procedures for certifying antibiotics and handling new drug applications, we likewise require data to show that the proposed conditions of use of the antibiotic or new drug would not incur residues in milk. A few years ago we received numerous reports that cheesemakers were having difficulty in making cheese from certain batches of milk. It developed that these batches contained sufficient penicillin to inhibit the growth of the lactobacillus organisms. Subsequently, FDA required a revision of the directions for use of penicillin in the treatment of mastitis to limit the maximum single dose to 100,000 units and to warn that the milk was to be discarded for 72 hours. Under these conditions it has been shown that the antibiotic residue will be completely eliminated from the udder and the subsequent milk, uncontaminated. However, the problem of enforcement is fraught with practical difficulties. It apparently is not easy to convince dairymen that the milk of a cow being treated for mastitis with penicillin should be wasted for three days.

Under the new Food Additives Amendment FDA intends to apply the same stringent criteria to proposed food additive usages that may incur foreign substances in milk as to pesticide and drug usages. Food Additive Petition No. 1 can be cited here as an example since, as you may know from a recent press release, the Food and Drug Administration has concluded action on this petition and established a tolerance of 150 ppm Santoquin on certain dehydrated forage crops including alfalfa, and a tolerance of 0.5 ppm on meat and meat by-products. Chemically Santoquin is 1, 2-dihydro-6-ethoxy-2, 2, 4-trimethyl-quinoline. It has been found useful as an antioxidant in preserving the carotene and vitamin E content of dehydrated forage. Since alfalfa is a primary dairy feed, data were required to show that there would be no residue in milk of cows consuming forage bearing 150 ppm Santoquin. In order to achieve the sensitivity deemed necessary Santoquin labeled with C¹⁴ in the number 2

and number 4 positions of the quinoline nucleus was fed to a lactating cow and the milk analyzed. Our chemists evaluated the data and concluded that such data demonstrated there was no residue of Santoquin per se of abnormal metabolites in the milk. The data further showed that Santoquin is promptly excreted almost quantitatively in the feces and urine and that minute amounts are completely metabolized with the labeled carbon being incorporated chemically into the protein, carbohydrate, and fat of the milk.

The Food and Drug Administration has kept a watchful eye upon the pesticide and antibiotic residue picture in milk through periodic nationwide surveys of fluid market milk.

Since 1954 four surveys have been conducted to determine the antibiotic content of milk. In the first survey in 1954, 3.2% of 94 samples was found to contain penicillin. In the second survey in 1955 474 samples were tested and 11.6% was found to contain penicillin. The third survey carried out later in 1955 was more comprehensive, 1706 samples being collected in the 48 States and the District of Columbia. Penicillin in concentrations of 0.003 to 0.550 unit per ml was found in 5.9% of the samples. About 1% of the samples appeared to contain one of the tetracyclines, bacitracin, or a combination of antibiotics, for which definite identity tests were not available.

The current and fourth survey is likewise quite comprehensive, approximately 1200 samples being collected in August, September, October, and November 1958. Although the analytical work is not quite complete, this survey shows a definite decrease in the incidence of penicillin - contaminated samples -- approximately 3.5% in 1958 as contrasted with 5.9% in 1955.

In 1955, 800 of the 1706 milk samples examined for antibiotic residues were also subjected to bioassay for residues of pesticides. About 62% of the samples tested showed the presence (including trace amounts) of pesticide residues of chlorinated hydrocarbons. No organic phosphates were detected.

Two rather limited pesticide residue surveys of milk were conducted in the winter of 1956 and the summer of 1957. These two surveys, while far from conclusive, did indicate a lower order of incidence of pesticide residues than the 1955 survey.

In 1958, most of the samples examined for antibiotic residues were also analyzed for pesticide residues. Of about 800 samples analyzed by

a paper chromatographic method, 4% showed more than trace amounts (0.1 ppm or more) of chlorinated hydrocarbon residues; and of 168 of these same samples further examined using a total bioassay procedure about 13% showed more than trace amounts of residues. A higher percentage of incidence by bioassay is to be expected because it reflects the sum of the minute amounts of all the pesticide residues toxic to the test organism, which is the common housefly.

Although it is difficult to compare the findings in this survey with those in the 1955 survey because more sensitive procedures have been devised since 1955, it is quite clear that there has been a definite improvement in the milk residue picture. As in the 1955 survey, DDT was the outstanding offender in the current survey. Where the sensitive bioassay procedure was employed in essentially the same manner in both surveys, 33% of the 1958 samples gave a positive test for chlorinated hydrocarbon pesticide residues (which includes trace amounts) as compared with 62% in the 1955 survey. Moreover, in the 1955 survey the samples consisted of market milk generally pasteurized and ready for the consumer; in other words, the output of many individual producers was mixed. In the 1958 survey the primary purpose was to pinpoint the source of contamination. Therefore, these samples were drawn from bulk tank trucks in which was mixed the raw milk output of only a few producers, generally less than a dozen. Thus, in the 1958 survey one might have expected a higher incidence of very excessive residues, but our tentative findings do not indicate this to be a fact.

Where substantial residues were encountered in a bulk truck sample, milk of each individual producer was checked to spot the "high-residue" producer and a follow-up made to the farm to discover whether the contamination was coming from the use of contaminated feed, or from the use of improper sprays on the cows or in the barn. So few follow-ups were warranted on the basis of the bulk truck analytical results that we have not been very successful in obtaining adequate data to answer this question. However, the feeding of silage or fodder from DDT-sprayed corn or sweetcorn appears to be one of the leading causes of DDT-contaminated milk.

Paper chromatography and bioassay employing houseflies have been found to be the most useful methods for examining milk for a large number of unknown pesticide residues. After "cleanup" of the milk extract on a florasil column, a magnesia column, or a Davidow column, and at least two of these are required to include the most probable pesticide residues, the extract is subjected to paper chromatography and to bioassay. Paper chromatography permits identification of the residue and its

semiquantitative estimation, while bioassay affords a measure of the total toxicity of the residue to the housefly. In combination with paper chromatography for identification, bioassay can be relied upon to give a quantitative measure of the residue.

The improvement in the pesticide and antibiotic residue picture for milk in 1958 over 1955 encourages us to continue a vigorous educational and informational program on the proper dairy usage of pesticides, antibiotics, and drugs. Historically, fluid milk has been considered primarily the responsibility of local health authorities. However, we are concerned also since milk is the source of many important dairy foods. Therefore, we shall strive to reduce the incidence of harmful residues in milk to the irreducible minimum by employing all possible avenues of action.

Let me emphasize that, of this date, there are no tolerances (except zero) for foreign substances in milk and that milk in interstate commerce is illegal if it contains any pesticide residue, antibiotic residue, or drug residue. Furthermore, as soon as the Food Additives Amendment becomes fully effective, milk containing any foreign substance not generally recognized as safe will also be illegal in interstate commerce.

We are very appreciative of the help we have received in the past on our educational programs from State and local public health officials such as you people here; from the U. S. Department of Agriculture, particularly the Extension Service; from State agricultural agencies; from national farm organizations; and from industry organizations such as the American Butter Institute. In this connection I should like to call your attention to a little leaflet entitled "Safe Use of Pesticides on Dairy Farms" distributed by the American Butter Institute. The Food and Drug Administration was very pleased to assist in the preparation of the guide lines laid down in this leaflet for the safe use of pesticides directly on dairy cattle, in dairy barns, and on dairy forage. This is an excellent example of the type of cooperation in an education program which is paying very fine dividends, indeed.

We look forward to continued cooperation on our common problems for we are quite cognizant of the fact that the freedom of milk from foreign substances depends primarily upon informed and responsible usage of pesticides, drugs, antibiotics, and other chemicals.

INSECT AND RODENT CONTROL IN DAIRIES AND MILK PLANTS

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I. Introduction

1. One day last week while looking through some 1957 issues of the magazine "Pest Control," my eye was caught by a column heading entitled SANITATION VIOLATIONS. In glancing through this listing of seven items I discovered that two of the seven involved milk, aspects appropriate to our discussion this hour. The two items read as follows:
 - a. "A Mitchell, S. D. creamery was fined \$1,000.00 and its manager \$200.00. It was accused of making butter from filthy cream containing insect fragments, rodent hair, and manure."
 - b. "A \$200.00 fine against a Lowville, New York, cheese factory for producing cheese containing insect and manure fragments and preparing it from dirty milk in an insanitary plant."
2. Since the dairy and the milk plant are usually though not always separate establishments, at different locations, and since the problems involving insect and rodent control together with their solutions will vary somewhat between dairies and milk plants, we will consider each subject separately with each type of installation.

II. Rodent Control in the Dairy

1. Suppose we consider rodent control in the dairy first. The need for rodent control in and around dairy farms may vary considerably. Two factors generally contribute to rodent infestation:

- a. The type of construction of the buildings
 - b. The level of sanitation and maintenance.
2. If the construction of the buildings and the type of house-keeping practiced are such that ample harborage is afforded for rats and mice, the likelihood of rodent problems existing is great. If, together with ample harborage, a low level of general sanitation is maintained, the possibility of a serious rodent problem existing or developing is especially great.
 3. Or, if a low level of sanitation exists, existing permanent and temporary harborage may be supplemented by extensive burrows around various outbuildings, concrete platforms and other paved areas.
 4. In Section 7, item 24r of the Milk Ordinance and Code, one of the criteria for satisfactory compliance is that, "the immediate surroundings of the dairy are kept neat and clean, and free of rodent harborages and insect breeding areas (places)."
- a. Frequently structural harborages may be eliminated by minor alterations.
 - b. Harborage other than structural usually results from poor storage of both usable items and junk. This type harborage is called "temporary."
 - c. Usable items can be stored in an orderly manner on racks off the floor or hung on walls, except in milk houses, so that rodent harborage is not afforded. Accumulated junk should be disposed of.

Manure piles - rats sometimes burrow into -
warmth in winter. Removal of piles of lumber
and debris - harborage.

- d. The rat proofing of many of the farm structures, including the farm house, would be helpful in rodent control. It would seem mandatory that the milk house be ratproof; animal food or feed should be stored in ratproofed bins, rooms, cribs, or silos.
- e. Other aspects of sanitation for rodent control around

the farm include the proper storage and disposal of household garbage. Rodent control around chicken houses and other outhouses are of importance.

5. Sanitation considered in a broad sense is the principal means of rodent control.
6. However, for a quick knockdown of rodent populations, more complete control, and to prevent new infestations from becoming well established, chemical control serves a useful purpose.
7. Probably the most widely used chemical for rodent control around farms is the anticoagulant. A number of anticoagulant poisons are now available including; warfarin, pival, fumarin, PMP, and diphacin. The commercial companies usually mixed one part of anticoagulant to nineteen parts of bait, such as yellow corn meal.
8. Some of these are available in water soluble form.
9. Anticoagulant baits, dry or liquid, are placed for consumption in plates and trays and watering devices, chicken fountains, etc., in protected locations or in permanent bait stations, except in milkhouse or so placed as to contaminate feed or water. Use traps in milkhouse if a rat gets in through door or drain.
10. Red squill may also be used with relative safety and zinc phosphide baits are sometimes used. Should be able to obtain control without using such especially dangerous chemicals as 1080 or thallium.
11. Use of traps for rat and mouse control around feed bins, etc.

III. Rodent Control in the Milk Plant

1. Although less likely to have a rodent infestation than dairies, the milk plant is subject to rodent infestation.
2. Again sanitation and good housekeeping practices should play the major role in making the milk plant unattractive as a home for rodents.

- a. Harborage elimination.
 - b. Rat proof construction is recommended.
 - c. Good housekeeping, inside and outside.
 - d. Storage of items like sugar, chocolate, wax, parchment paper, that might constitute food for rodents, in ratproof containers, bins or rooms is desirable.
 - e. Good storage and disposal of employees' lunchtime food scraps.
 - f. Plant surroundings should be kept neat and clean and free from rodent harborage and fly breeding material.
 - g. Sometimes harborages may be in warehouses or other structures as far as a block away, the rats living there, coming to the plant at night.
 - h. Retail stores in connection with milk plants sometimes have direct openings into plants. Self-closing doors should be used.
- 3. Chemical control - should the need arise, rodents inside milk plants may be controlled by the use of anticoagulants or single-dose poisons used with care, in storage areas or (non-milk) processing areas. Neglected areas - office and office supply rooms provide harborage especially for mice.
 - 4. Traps may also be used. Use of traps preclude rodents' dying in inaccessible places and causing an odor nuisance. Under some conditions use of traps may be preferable to the use of poisons.
 - 5. To prevent rats from coming in buildings and possibly running over processing equipment, doors should always be kept closed when not in use.

IV. Fly Control

- 1. Flies - Source Reduction in Dairies
 - a. Flies are the most important insects requiring control in and around dairies. Not only do flies present a danger

of contamination but the U. S. D. A. has shown that milk production is increased when dairy cattle are not bothered by flies. In some areas gnats are also a problem getting into milk, etc.

- b. There are three species of flies most commonly found among dairy herds; the horn fly, the stable fly and the house fly. The little house fly, Fannia, is often common. All have the same four stages; egg, larva, and pupa, an adult completing development in from about 10 days to 2 weeks.
- c. Again, as in rodent control, source reduction (the elimination of fly-breeding sources), is the principal factor in the control programs.
 - (1) For the control of the horn fly (Siphona irritans) this may not be too practical for their larvae develop chiefly in fresh droppings in pastures, or breed in decaying straw and hay.
 - (2) However, for house fly and stable fly control source reduction can do much to reduce the fly populations around dairies.
- d. Since flies can develop from egg to pupa in less than 1 week, and the larvae ready to pupate tend to leave the larval breeding media, at least semi-weekly removal of manure from the dairy barn and its immediate vicinity is essential. Manure from other nearby areas such as hog pens should receive the same treatment.
 - (1) Manure should also be cleaned up at least twice a week from nearby stables, bull pens, calf pens, or other sources of production.
 - (2) Actually, daily removal of manure from all these locations would be even more desirable.
 - (3) These recommendations apply to fly breeding seasons.

- e. Clean up of manure must be thorough in order that no breeding places or partially developed larva remain. Some construction lends itself to easy cleaning though in many cases thorough cleaning and removal are quite difficult because of construction features.
- f. If daily clean up of manure of a manure-bedding mixture is accomplished, it may be stored for no more than about 3 or 4 days in a pile on the ground in a location where it is not accessible to cows or other animals. Preferable storage would be in fly tight metal containers.
- g. At the end of this storage period the manure should be spread thinly and evenly on the fields. This spreading effects a quick drying which prevents the complete development of the larvae.
- h. The bottom of the wagon or spreading machine should be scraped clean before its return to the barnyard area.
 - (1) In northern regions or where manure-pack, or loose housing is practiced, in the winter, the pack should be removed and disposed before the fly breeding season begins.
- i. Long term storage of manure in racks or bins is only satisfactory during fly breeding seasons when the racks or bins are constructed and maintained in such a manner that:
 - (1) Adult female flies may not lay eggs on the manure.
 - (2) Larvae cannot leave the bin to form puparia and adults.
 - (3) Fully emerged adults cannot leave the bin.
- j. For control of production of house flies and other species attention should also be paid to:
 - (1) Storage and disposal of household garbage.
 - (2) Clean up of spilled feeds which might otherwise become wet.

- (3) Proper disposal of spoiled silage.
- (4) Proper disposal of wet and decaying hay; removal of dead animal matter,
- (5) Pooled waste from drains of barns and milk houses should be eliminated by proper drainage to the outside, - otherwise fly breeding.

2. Flies - Source - Reduction at Milk Plants

- a. The opportunities for source reduction control of flies in and around milk plants are usually not as numerous as in the dairy, unless the dairy and milk plant are together, but they may still be important.
 - (1) Fly breeding may occur in curdled milk in floor crevices such as expansion joints, between floor tiles where the grouting has eroded, and under footings of machinery where spaces occur and spilled milk or milk products would form a suitable breeding medium.
 - (2) Fly breeding may also occur, outside the plant in:
 - (a) Cracks and crevices of loading platforms.
 - (b) Underneath wooden loading platforms.
 - (c) Crevices between cobblestones of street adjoining loading platform.
 - (d) Poorly stored refuse of adjoining business establishments or homes.

3. Flies - Chemical Control - at Dairy Farms

- a. Where horn flies are a problem, chemicals may be the most practical method of control. Horn flies suck blood and spend practically all of their adult lives directly on the cattle. Until the tolerance of methoxychlor in milk was established at zero, a 0.5% water wettable suspension was sprayed directly on cattle at the rate of 2 quarts per animal.
 - (1) At the present time methoxychlor may be applied as a 50% powder sprinkled on the back and neck at one tablespoonful every three weeks.

- (2) Pyrethrins (0.05%) with piperonyl butoxide or MGK 264 as a synergist (0.5%) as a wet spray of 1-2 quarts may be applied to the animals every 3-10 days. This may also be used daily as a mist spray in strength of 1% and 10% as one can also use 3-5% lethane (1-2 oz. per treatment) or thanite.
- b. For stable flies and mosquitoes pyrethrins plus synergist; 0.05% to 0.10% pyrethrin plus 0.5% to 1.0% synertist applied at 1-2 quarts of wet spray per animal every 2-3 days or 1% to 10% strength, 1-2 oz. per treatment as a mist spray daily. A 3-5% lethane or thanite mist spray may also be used daily at 1-2 oz. per treatment.
- c. Chemical Control of Flies and Other Insects - at Dairy Farms
- (1) See Table from Agricultural Handbook #120, 1958.
 - (2) Diazinon (25%) or parathion (5-10%) treated cords installed at a rate of 30 linear feet per 100 ft.² are approved for use in dairy barns.
 - (3) Korlan (DOW-ET-14) also registered for use in dairy barns in formulations containing approximately 1%. In Savannah, it has given excellent control of house flies for 8-9 weeks when applied to interior surfaces of dairies at a rate of 200 mg/ft.² applied at rate of 100 mg/ft.² gave effective control for 4-5 weeks.
 - (4) Dieldrin may be applied to outside surfaces of dairy barns as a .625 or 1/25% emulsion to the point of run-off.
 - (5) A Dairy Barn Fogging Method for Fly Control is described by Dr. E. H. Fisher, (University of Wisconsin) Journal of Economic Ent., June 1955, Vol. 48 #3, p. 330.

"A method for fogging quick knockdown spray; 0.1% pyrethrins and 1% piperonyl butoxide in deodorized kerosene. @ 1 ounce per each 10 linear feet of barn length. Barn averaged 35 ft. wide, 8 1/2 ft. high.

"A four nozzle unit with attached 1/2 gallon spray container was suspended from the ceiling near the center of the barn, height adjusted to disperse the insecticide just below the lowest beams. The nozzle unit was connected with a portable compressor by means of a hose or other suitable air-line.

"Fogging was done shortly before milking while cattle were stanchioned, and doors and windows were closed to prevent draft. Doors and windows remained closed for about 2 minutes after completing the insecticide dispersal. Milking operations were begun immediately thereafter.

"By fogging regularly as necessary (75 to 100 times during the summer) insects were controlled in the barn and on the cattle and cattle were afforded protection in pasture. Insects involved were house flies, horn flies, deer flies, horse flies and mosquitoes. The method was applicable to enclosed holding pens for milking parlor set ups, as well as for stanchion barns."

(6) "Permanent installation of the unit in a dairy barn is more practical for the more automatic features of "pushbutton fly control."

(7) Vaporizers - should not be used!

4. Flies - Chemical Control at Milk Plants

- a. Spraying, space pyrethrins and synergist inside plant.
- b. Residual spraying of loading platforms and adjacent outside areas.

5. Screening for Control of Flies

A complete program for reducing fly infestations to control levels entails three distinct operations. Two, sanitation and chemical, have already been discussed. The third is screening or the prevention of fly entry by some mechanical or other barrier.

a. Dairy Farms

- (1) Some of the buildings of the dairy farm do not lend themselves to effective screening. It is usually practically impossible to screen the dairy barn effectively. At installations having separate "milking parlors" use of screens at windows and doors not used by the cattle may help considerably. Swinging doors through which the animals enter and leave the washing room help reduce the number of flies entering the milking locations. Between milkings any flies in these sections can be killed by aerosol applications of pyrethrum.
- (2) In any event the milk house should be well screened, doors and windows, and aerosols of pyrethrum may be used. Doors should be self-closing.

b. Screening in Milk Plants

- (1) Adequate screening of milk plants can be quite helpful in reducing the number of flies gaining access to the operating rooms. It is practical to screen all windows and doors except those in the loading platform area. Double self-closing solid doors must be used on loading and receiving platforms.
- (2) The installation of fans above and on the inside of loading platform doors may help discourage fly entrance. Inside doors should be screened when it is desirable that they be open during warm weather.

c. Doors and Windows (Subparagraphs (1)-(4) below are quoted or adopted from the 1953 Milk and Ordinance Code, Item 3p., pages 76-77.)

- (1) Unless other effective means are provided to prevent the access of flies, all openings to the outer air shall be effectively screened, and all doors shall be self-closing.

- (2) Public-Health Reason - Freedom from flies in the milk plant reduces the likelihood of contamination of the milk. For information on disease transmission by flies, see item 7r (Public-Health Reason).
- (3) Satisfactory Compliance. This item shall be deemed to have been satisfied --
- (a) When all openings to the outer air are effectively screened; all screen doors or other doors, including interior doors, are self-closing; and all doors to the outer air open outward; or
 - (b) When fans of sufficient power to prevent the entrance of flies are in use at all ineffectively protected openings; or
 - (c) When effective electric screens or screen panels are installed at all openings to the outer air; or
 - (d) When any effective combination of (a), (b), and (c), exists; or
 - (e) When flies are absent in the immediate vicinity of the plant.
- (4) Openings through which cans, crates, or other articles are loaded in rapid succession, making impracticable the proper use of self-closing screens, may be protected by properly constructed flaps, or by fans of sufficient power and so located as to prevent the entrance of flies. Such fans must be in operation at all times when doors are open.
- (5) Window - and door - screens must be tight-fitting and free of holes. This applies also to screens for skylights and sunsoms. This item refers to the physical facilities for exclusion of flies from the interior of the plant, and must be enforced during those seasons of the year when flies are present. The actual presence of flies inside the plant should be considered a violation of item 5p [1953 Milk Ordinance and Code, pp 77-79].

V. Cockroaches

1. Cockroaches in Dairies

a. Milk house

- (1) Elimination of harborage - cracks, etc.
- (2) Proper construction of building and installation of equipment to preclude harborage.
- (3) Use of pyrethrum aerosol

b. Feed bins in connection with barns. (Often American Roaches)

- (1) Make bins cockroach proof.
- (2) Many cracks and crevices in barns provide hiding places.
- (3) Could use residual sprays to roach hiding places.

2. Cockroaches in Milk Plants

a. Are often pests in milk plants.

b. Often find harborage on undersides of processing equipment, in warm places such as housing of electric motors, pumps, in switch and control boxes, in cracks, and crevices, around doors and in walls.

c. Mallis (1954) reported that a dairy in San Antonio found its bottled milk contaminated with coliform bacilli. The contamination was traced to the bottle caps, and it was only after the bottle caps were stored where cockroaches could not enter that the contamination disappeared.

d. Scrupulous sanitation, good housekeeping and maintenance, proper location of equipment away from walls, etc., will help control cockroaches. However, even in establishments we would consider good, some food and harborage may be available.

- e. Best procedure to control "hiding" insects such as roaches is good sanitation and maintenance which includes the caulking of all possible cracks and crevices in which roaches might hide or gain access to hiding places. Example: Hollow tile walls.

3. Chemical Control of Cockroaches

a. Sprays (Spot treatment, except for Pyrethrum)

- (1) Malathion (oil base solution as residuals)
1-5%, often 2 or 3%.
- (2)* Diazinon (oil base solution as residual) 0.5%.
- (3)* Dipterex (2% oil base spray residual) above
applies as residual to resting places.
- (4)* Pyrethrin - aerosol formulations with synergist used to attain quick kill in heavy infestations directed at harborages. Frequent applications may be necessary but safe control may be realized.

b. Dusts

- (1) Malathion 1-5%, often 3% is often used inside dairy plants for roach control. Care should be taken to use dusts only in situations where air currents are lacking, such as in enclosed spaces.

- (2) Sodium fluoride (Quoted from Pest Control June 1958).

"Sodium fluoride is an effective, very toxic dust against both resistant and non-resistant German roaches. It must be very finely ground to be effective. It is a contact poison, so roaches must run through it.

"This chemical is frequently mixed with pyrethrum in a one part pyrethrum to 2, or 3 or 4 parts of sodium fluoride, depending on the users preference. One standard mixture today

*Would tend to prefer these for use in milk plants.

is 65% sodium fluoride, 35% pyrethrum powder (by weight). Some claim 75% - 25% the best 'all round' mixture.

"Apply gently and evenly to keep dust from fluffing into the air and getting into the operator's nose.

"It should never be applied where food or food utensils are exposed. Most States and cities require that it be colored Nile blue.

"It has a high toxicity to man - keep away from children, pets and irresponsible persons."

Sodium fluoride is generally not recommended for milk plants, because it is a powder which may be blown into milk or dairy products.

- (3) Pyrethrum dusts (1%) are useful against both susceptible and resistant roaches.
- (4) General

In an article in Modern Sanitation in August 1958 Dr. Edward M. Searls stated "generally speaking however, insecticidal powders applied by means of a duster to the roosting and hiding places of roaches and similarly furtive insects is by far the quickest, safest, most economical, effective and efficient method of roach prevention available today."

He states also, "There are only two requisites to successful dusting. First, every precaution must be followed to see that drifting powder does not find its way into food. The second is to make sure that the atmosphere in the dusted area is sufficiently static that the powder may settle out as soon as the draft of air from the duster loses its velocity."

This article by Dr. Searls recommending the use of malathion and diazinon powders was criticized by Edward Holmes, Executive Director of the American Sanitation Institute, in regard to its application to dairy plants.

Mr. Holmes states that, "Powders are so easily distributed about the plant, so easily blown about by air currents, and so easily mistaken for other substances that it is our firm conviction that it is not safe to have insecticidal powders for use in a dairy plant of toxicity represented by malathion and diazinon."

He also states, "that we are convinced that it is virtually impossible to carry out the two requisites to successful dusting as stated by Dr. Searls."

The American Sanitation Institute currently recommends oil base solutions of malathion and diazinon in dairy plants - where they may be used to treat unclosed spaces, cracks, crevices, corners and inside motors."

VI. Insects in other Situations

Procedures for Insect Prevention and Control in Plants Processing Non-Fat Dry Milk Solids.

1. In these plants, in addition to the possibility of cockroach infestation, stored-product insects such as beetles are often troublesome.
2. The main points of Insect Prevention and Control of this type of plant are as follows, according to the Stored Product Insects Section, ARS, USDA.
 - a. "Use industrial vacuum cleaner every two months-more often in certain areas.
 - b. "Use exhaust fans, clean traps regularly, and prevent accumulations of dried milk powders.
 - c. "Apply 1/2% lindane spray every 2 months immediately after vacuuming. Spray all sections where insects hide or crawl, except where milk powder could be contaminated. Lindane is safe to use in processing, packing, and storage rooms when applied as indicated."

VII. Precautions and Safeguards in Handling and in Use of Pesticides

1. Read the label.
 - a. Follow instructions.
 - b. Pay attention to all cautions and warnings.
2. Keep chemicals in labeled containers. Never place poison in an unlabeled container.
3. Wash hands, face; change clothes.
 - a. Wash hands and face frequently after spraying and dusting and after preparing or mixing chemicals.
 - b. Avoid pesticide contact with skin, eyes, and mouth.
 - c. Change clothes often; especially after contamination.
4. Keep pesticides away from children and unauthorized persons.
 - a. Store pesticides in locked room, garage, cabinet.
 - b. Never leave such materials where children, irresponsible persons or pets can reach the containers or knock them down.
 - c. Never store pesticides near food, feedstuffs, medicine, utensils, etc.
 - d. Never store pesticides in milk house or in operating rooms of milk plants.
5. Dispose of empty containers promptly
 - a. Burn bags and fiber drums. Stay out of smoke. Organic phosphate insecticides are toxic as gases. Anyone within the area of the smoke should be evacuated from the area where vapor or fall out may occur. Decontamination after fire is extinguished can be accomplished by liberally washing area with an alkaline solution.

- b. Wash non-returnable containers for liquids, inside and outside. Crush or puncture to prevent re-use. Bury if possible.
 - c. Returnable containers should always be handled with safety precautions observed; wash outsides thoroughly and return promptly.
6. The hazards of the careless use and storage of 1080 have been mentioned.
- a. The emphasis on 1080 should not be implied to mean that it is the only poison to be handled carefully.
 - b. There have been recent deaths in Texas from the thallium cockroach poisoned baits and continuing losses occur through-out the country from arsenic, phosphorus, strychnine, organic phosphorus compounds, chlorinated hydrocarbons, (even household chemicals such as kerosene, carbontetrachloride and drugs).
7. Poison control centers have been established in a number of cities in the United States. They are concerned with the prevention of accidental poisoning, the coordination of treatment measures given in the home, the doctor's office, or the hospital, and with making information for treatment available to clinics and physicians. Another objective in the prevention of poisonings is improved labelling of toxic materials, to include a list of ingredients and the antidotes. The poison center keeps on file a list of toxic materials normally found in that community and maintains a summary of the best current knowledge of treatment of accidental poisonings.

STAPHYLOCOCCUS FOOD POISONING IN MILK AND MILK PRODUCTS

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It was recognized a long time ago that some kinds of food poisoning, at least, could be caused by something other than the commonly recognized chemical poisons such as lead, copper, arsenic, and the like, but the discovery of staphylococcal enterotoxin is a recent event. This comment from the Edinburgh Medical and Surgical Journal was made in 1830: "Certain articles of food have frequently been observed on the continent to acquire poisonous qualities of a peculiar kind and in a way which chemists and physicians have not hitherto been able to explain satisfactorily. Among these articles the most frequent are a peculiar sort of sausage and a particular kind of cheese used in Germany. Both in France and Germany bacon and ham and pastries have been found to acquire poisonous qualities analogous to the cheese and sausage poisons already mentioned. A thorough investigation by a noted investigator set aside the popular notion that these accidents are caused by metallic poisons, but he was unable to discover the real cause." In 1879 Henry Leffman, lecturer in toxicology for the Jefferson Medical College, called attention to the frequency with which cream puffs had been implicated in outbreaks of food poisoning. He wrote, "I have made chemical examinations of portions of cream puffs that have caused trouble, but have not found anything that could be assigned as the cause of the accident." In 1884 the following statement with reference to food poisoning caused by cheese was made by Professor V. C. Vaughn: "It is well known that cases of severe illness follow the eating of some kinds of cheese. Indeed, such instances have been observed in various parts of the world for the past 300 years. They are frequent occurrences in the North European countries and in the United States and less so in England, while in France where much cheese is eaten we find no record." In Northern Ohio a few years ago the reputation of a large cheese factory was said to have been destroyed when a great number of cases of severe illness occurred among those who had eaten its products. In Michigan during the past six months 300 cases of cheese poisoning have been reported. Professor Vaughn extracted and filtered material from these cheeses and ate some of it,

and developed typical food poisoning. Microscopic examination revealed spherical bacteria which had been discovered by Pasteur in 1880. Vaughn deduced that these bacteria were responsible for some chemical change that caused the symptoms of intoxication, but he was unable to identify the toxic material.

The same year Sternberg experimentally ate some cheese that had been involved in a food poisoning outbreak and developed typical symptoms. Sternberg commented as follows: "It seems not improbable that the poisonous principle is a ptomain developed in the cheese as a result of the vital activity of a micrococcus or of some other microorganism which had preceded it." In a textbook of bacteriology published in 1901, Sternberg discussed the problem of cheese poisoning under the heading of "Tyrotoxican," as follows: "This material was first obtained by Vaughn in poisonous cheese, and subsequently by the same and other chemists in milk and ice cream. Tyrotoxican is very unstable and is decomposed when heated with water to 90°C."

The first well documented account of the incrimination of staphylococci in food poisoning occurred when Barber was able to isolate staph consistently from the milk of a cow with mastitis in 1914 in the Philippine Islands. The milk when consumed without prior refrigeration caused considerable gastroenteritis in human beings, but none at all in test animals including monkeys. Unfortunately, the significance of this work went unrecognized for about 15 years, and food poisoning in general was ascribed to other bacterial agents until 1929 when cream filled cakes were definitely implicated in an outbreak in Chicago. The long delay in recognition of staphylococci in food poisoning may be attributed largely to the immense amount of publicity given salmonella or paratyphoid organisms, and the fact that when salmonella were not found so much effort was invested in attempting to detect heat stable products of the salmonella group.

With a revival of interest in staphylococci in the early '30's, a tremendous amount of literature began to build up, but unfortunately much of it was exploratory and contradictory. After a period of some years of activity, interest showed a considerable decline, which is probably correlated with the increased use of antibiotics during the 1940's. A second peak is obvious in the literature beginning early in this decade, and at the present time there is a tremendous amount of material being written and published on staphylococci. The majority of it, however, is of a medical nature as a result of the problems involved in the so-called hospital-acquired staphylococcal disease. This interest level will probably remain high until practical answers to the problem of staphylococcal infections can be found.

As long ago as 1916 Staphylococcus aureus, the organism most of us think about when we discuss staph poisoning in food, was discovered in cow's milk by Evans who postulated that the organisms were introduced into the milk from the udder. Later on, in the 1930's, it was found that Staphylococcus aureus was the most common organism in certified milk that was responsible for reducing methylene blue at 37°C., and the strains that were found in their certified milk were apparently identical with those isolated from pyogenic infections in man. A few years later when Weller isolated Staphylococcus aureus from a third of the samples of milk from 500 cows in a number of dairy herds, he postulated that the frequency was probably on the rise with gradual reduction of streptococcal mastitis by use of antibiotics. These early observers, who were equipped with inadequate laboratory tools, considered the most likely source of food poisoning staphylococci to be the cow, and the isolation of enterotoxogenic strains from the udders of cows encouraged this belief. However, in recent years most investigators of staphylococcal gastroenteritis have come to the conclusion that the most likely source is the human nose, with the human skin a close second. When one considers what a good medium for growth milk and milk products can be for staphylococci that can cause food poisoning, it is surprising that more outbreaks are not reported. In practice there are undoubtedly many cases of food poisoning from this source that are never reported since only a relatively few states require reporting of staphylococcal food poisoning or for that matter, for other kinds of food poisoning. In addition to this, there is undoubtedly a good deal of confusion as to the actual etiology of many food poisoning cases since fewer than 50% of cases of food poisoning are actually identified by culturing of the organisms responsible. This is particularly true in the case of staphylococcal food poisoning as compared with that caused by salmonella, where a diagnosis is seldom made without identification of the organism itself. A recent estimate by K. F. Myer indicates that foods, other than milk and its products, are the major vehicles for 86% of present day gastroenteritis. As might be expected, just about all kinds of prepared milk and milk products have been implicated in staphylococcal food poisoning, and it is reasonable to assume that those that have not been reported as such probably have actually been involved at some time or other. Bakery products, interestingly enough, usually those that are cream filled, have been found to be the most commonly contaminated foods causing staphylococcal poisoning. Bakery employees have been found to carry the same strains of staphylococci as their products that caused food poisoning in a number of well-documented cases.

Since milk and milk products make up such a large amount of the total quantity of food consumed in this country and abroad, it is only

reasonable to assume that various laboratory investigators have been curious about why there are not actually more cases of food poisoning reported.

Various investigators have commented on this aspect of the problem, and have found that, under favorable conditions, staphylococci are able to grow freely at 30°C. and 37°C., and reasonably well at 25°C. Growth is slow below 25°C.; and other organisms, such as streptococcus lactis, may interfere with or inhibit the growth of staphylococci, if they are present in about equal numbers, even at 30° or 37°C. These investigators were not able to determine the number of staphylococci required to produce enough enterotoxin to cause food poisoning, but reasoned that, even if toxin production required about 10 million cells per milliter, milk held at less than 80°F. for less than 24 hours should not cause illness.

They felt that, generally speaking, it must be very uncommon for milk to be toxic at the time it is withdrawn from a mastitic udder, and that the following conditions must be met before food poisoning could occur from this kind of milk: (1) it must be drawn under good hygienic conditions, in order that adventitious organisms could not gain access in large enough numbers to outgrow the staphylococci already in the milk; (2) it must be held, at a fairly high temperature for a fairly long time, i. e., above 80°F. for at least 24 hours; (3) it must not be diluted with milk from other cows, thus diluting the toxin below the point where it would cause illness; (4) it must not be inactivated by heat. These conditions probably occur very seldom, and may well account for the relatively few cases of staphylococcal food poisonings reported from milk.

Investigators have also concluded that milk infected with staphylococci after withdrawal from a healthy udder would have to be inoculated with an extremely large number of organisms, such as from a discharging abscess or boil, in order to compete with the flora already present, and would then have to increase tremendously under very advantageous temperature conditions in order to produce enough toxin to cause disease.

As might be anticipated many of the papers in the literature are concerned with the epidemiology of staphylococcus food poisoning rather than the laboratory aspects. The following discussion from a paper by Rolando Armijo, et al, is concerned with an investigation of 19 cases of food poisoning over a period of a few months in Puerto Rico, reads as follows:

"Gastroenteritis outbreaks of staphylococcal enterotoxin etiology are certainly quite common. However, spray-dried milk solids have been incriminated in but one previous series of outbreaks. These occurred in England and after thorough study implicated milk processed there. Because of the increasing and now very substantial quantity of production and widespread distribution of spray-dried milk, this series of outbreaks in Puerto Rico assumes considerable significance.

"Although bacteriologic studies were negative, the clinical symptomatology and incubation period, in the light of negative toxicologic findings, strongly implicates staphylococcal enterotoxin as the responsible agent. Indicative, but not conclusive, food histories suggested spray-dried milk as the responsible food. Confirmation of this was achieved by human volunteer experiment. The unusual geographic pattern of the outbreaks was explainable through particular irregularities of the milk distribution from warehouses. Epidemiologic evidence indicated at least three particular lots of milk from one of the seven processing plants involved. Bacteriologic plate count records of samples from this plant were shown to be clearly in excess of those submitted by the other plants.

"Evidence that the staphylococcal enterotoxin was present in the dried milk prior to reconstitution was adduced from the human volunteer experiments in which the milk was consumed almost immediately after reconstitution. This was substantiated by studies at the schools where it was found that in nine of 16 schools the milk had been allowed to stand less than three hours following reconstitution. Anderson and Stone showed that even with reconstitution of the milk in an artificial cream preparation, little staphylococcal multiplication occurs until after a six-to-seven-hour period elapses.

"Considering that the staphylococcal organisms are much more sensitive to heat than its enterotoxin product it seems reasonable to postulate that the negative bacteriologic results obtained in this present series of outbreaks might well be the result of the destruction of the organism, but not the toxin. A plate count of milk used in the human volunteer experiment revealed but 30,000 colonies per gm. of solids, a figure ordinarily certifying the milk to be 'extra grade.' That the staphylococcus is more sensitive to heat than its enterotoxin product is commonly recognized. Anderson and Stone have demonstrated that momentary heat drying in the production of dried milk is insufficient to destroy formed enterotoxin."

Among the most recent reports of staphylococcal food poisoning is one reported from Indiana in October, 1958, where contaminated cheese spread was implicated. Investigation revealed that the cheese spread had been prepared in a supermarket by blending several kinds of cheese, relish and mayonnaise, which yielded Staphylococcus aureus when cultured. In this case no source from which the contaminating bacteria came was reported.

The most recent well-publicized cases of staphylococcal food poisoning that involved large numbers of people were reported in the National Office of Vital Statistics Morbidity and Mortality weekly report released December 19, 1958, from which the following information is quoted: "Additional information has been received with reference to an investigation of the outbreak of food poisoning in Indiana and Michigan traced to the ingestion of cheddar cheese. A total of 66 cases has been investigated epidemiologically. Organisms isolated in the Michigan Department of Health Laboratory showed coagulase-positive hemolytic staphylococci with phage types 47-53-54-73-75-77 and Va 4. Examination of 24 samples of cheese in the Indiana State Board of Health Laboratory showed that all had concentrations of hemolytic staphylococci of greater than one million organisms with variable phage types.

"Dr. Ralph Heeren, Iowa State Department of Health, reports that the outbreak of staphylococcal food poisoning described in Morbidity and Mortality Weekly Report for the week ending September 20, 1958, has been traced to natural cheddar cheese. Hemolytic coagulase positive Staphylococcus aureus was isolated from samples of cheese served to the group of 200 persons who became ill."

As might be expected, a large amount of the laboratory effort that has gone into investigations of staphylococcal food poisoning has been concerned with isolating the enterotoxin, and with investigating its physical characteristics. As might also be expected when a complex problem is involved, the results of earlier investigations and those of more recent date frequently do not agree, causing a good deal of confusion in the literature.

Recent studies indicate that the enterotoxin is a water soluble protein with a molecular weight between 15,000 and 25,000, with an isoelectric point near pH 8.5. The toxin, at least in crude form, is somewhat antigenic. It contains a high percentage of lysine, and is trypsin resistant. It is relatively heat resistant, and frequently will survive boiling temperatures for periods of 15 to 30 minutes. As a matter of fact, it is not easily deactivated, and will resist chlorination in concentrations that would make milk completely unpalatable. It is

reasonably resistant to acids and alkalies, and will survive a pH as low as 5.0 and as high as 8.0, without any noticeable effect for periods up to a week. The material is slightly soluble in alcohol, but is not easily dialyzable. It has not yet been isolated except in a very crude form.

None of these properties, unfortunately, lend themselves to the development of a good bench assay procedure, and animal tests remain the only test assay methods available.

The recent literature on staphylococcal problems contains many references to phage-typing and its application to both hospital infections and outbreaks of food poisoning. Unfortunately, phage-typing of staphylococci is a much misunderstood technique, and its limitations are best appreciated in the State and regional laboratories that have worked with it. It was developed as an epidemiological tool, and as such, when properly used under the right conditions, it can be a fine definitive instrument. There has been a strong trend in the direction of attempting to correlate phage-type with virulence in the case of infections, and with enterotoxin production in the case of food poisoning; but to date, at least, no such dependable correlation has been shown. The picture is confused by some of the terminology used, since in the popular mind certain groups of phages are assumed to refer to the origin of sensitive strains of staphylococci, when in actuality the groups were originally based on minor serological differences. As a consequence, staphylococci isolated from food outbreaks may represent any of the so-called phage groups, and if a particular strain, for instance, is isolated from contaminated milk, this is not evidence that the organism necessarily came from a mastitic cow, since the same strain may have been implicated in hospital infections, as well.

Phage-typing finds its best application in those situations where the same phage type of staphylococcus can be recovered from contaminated food, from the person who became ill after ingesting the food, and from a known source, such as a food handler. When these conditions can be met, and they can be with some frequency, phage-typing then becomes an epidemiological tool without peer. Simple identification of enterotoxigenic strains as such from milk or milk products, or any other food, will have to await the development of a good bench test, probably through a serologic approach to the problem.

MODERN DAIRY PLANT SANITATION

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Introduction

This is a review of dairy plant sanitation today with particular attention to new cleaning procedures. The subject is approached from the viewpoint of the milk-quality-control official regulatory agency.

New methods of producing, handling and processing of milk and milk products and new cleaning procedures have changed the standards for product quality. Pipeline milking, immediate cooling, farm bulk tank and tank truck handling bring raw milk into the plant now with low bacteria counts unbelievable a few years ago. Improved detergents and more efficient methods of cleaning farm milk equipment have been most essential in this better production of high quality raw products. Recirculation and spray cleaning, even on farms, has taken the human variable out of the sanitation picture.

New plant processes have been introduced in recent years. New ultra-high temperature methods of processing milk have changed the bacteria standards for finished products. Flavor control equipment makes the product more palatable and attractive. Improved methods of sanitation in cottage cheese manufacture have aided greatly in the marketing and increase consumption of this wholesome product.

Modern Dairy Plant Sanitation

Plant cleaning procedures have been improved to go along with new standards of processing. The chemical industry has developed better balanced cleaners and more effective sanitizers; however, the greatest changes have been in the methods of cleaning.

Several years ago with the use of specialized cleaners and better engineering practices on installation, it became possible to clean most piping and some equipment "in place" without tear down. The extent of application of this method of cleaning and the distinct advantages from a sanitation standpoint are well recognized.

The next step was the spray cleaning of tank and tank trucks, processing vats and similar large equipment. Many plants now have this equipment. Several different designs of spray units are utilized. Originally it was the practice to install the spray units temporarily through the manhole, but most installations now are on a permanent basis usually through the top of the tank. Temporary units are still used in processing vats, but there is also a trend to permanent installation through the bridge of the vat.

It is possible to clean in-place vertical agitators, king gauges, coils and baffles. Horizontal agitators still present some problems and, until there is a re-design of bearing seals, such equipment should be removed and cleaned separately.

There are a variety of designs of spray units. Some operate on a rotating principle, but most are stationary. Some are not designed to be dismantled and inspected and therefore may not conform to milk codes.

Effectiveness depends on a proper spray pattern and installation plus the proper combination of water volume and temperature, and chemistry of cleaning solution. Most applications are designed for recirculation of cleaning solution and wasting of pre-and post-rinses. Sanitizing may be done through the spray device or by fogging in the normal manner.

There are many advantages to the operator. The entrance through the tank is eliminated when permanent installations are used. There is no possibility of interior damage to the surface of the tank and definitely no opportunity for contamination of the milk surfaces after cleaning. The operation is much more economical and much easier for the clean-up crew. With a proper spray pattern and an effective time-temperature - detergent combination a consistent day-in-and-day-out job is done. The human factor is eliminated and, above all, top quality results are assured.

One study encompassing swab tests of a spray cleaned tank on 21 separate days was made using five different swabbing points. The average for the entire period showed a count of 15.2 colonies in the total 40 square inches swabbed. Standards, of course, for sanitized surfaces provide for a maximum of 100 colonies per 8 square inches. These studies were made to observe the effectiveness of the spray cleaning unit and it is of unusual interest to note that these results were achieved after cleaning and before sanitizing.

The newest development, and one of major interest not only to industry, but also to the milk control official, is the application of automatic controls to the recirculation and spray cleaning procedures. Through the utilization of a sequence timer, all manual actions of operating pumps, making up of detergent solutions, controlling volume and temperature, circulation of rinses and cleaning solutions, and the operation of valves can be eliminated. The time-temperature-detergent combination of cleaning can be pre-determined for each system or systems of piping or equipment in the plant; and with the further elimination of the human factor, uniform dependable results can be guaranteed for all practical purposes.

For the benefit of the person responsible for quality control, whether a plant employee or a representative of an official agency, complete records can be set up ahead of time to show what is required. Daily records can be maintained thereafter on time-temperature-detergent factors, and any causes of high counts or improper cleaning can be more readily pin-pointed.

The engineering of a completely automated cleaning system is, of course, complex. For a number of years the milk quality control official has had to be equipped to check the operation of HTST units and similar complicated equipment to insure that standards for processing and product quality were maintained. A similar responsibility certainly exists in regard to the automation of cleaning procedures.

Furthermore, automation of processing procedures is the next step in the not too distant future. Already the routing of milk products through valves controlled and operated automatically is being undertaken. These valves are designed to be cleaned "in line" without removal for manual cleaning as is now practiced.

The regulatory agency representative must be fully aware of these newer developments and should be prepared to cooperate with the equipment designer and plant operator to insure (1) the proper design and installation of the equipment and controls, and (2) the efficient operation of the systems, both from the standpoint of product quality and of cleaning procedures. Undoubtedly new standards for cleaning efficiency need to be established. The record of cooperation between industry and public health in improving the quality of dairy products has been excellent. The milk control official can aid greatly in the present development, application and operation of automated cleaning systems and in the future automation of processing procedures.

INVESTIGATION FINDINGS OF HIGH TEMPERATURE
PASTEURIZATION OF MILK AND MILK PRODUCTS FOR
THE INACTIVATION OF PATHOGENIC MICROORGANISMS

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We have been conducting research at the University of Massachusetts on the thermal resistance of various microorganisms, primarily pathogens, which may be associated with milk or milk products. The first studies done in this area were of the extinction data type with very fast heating and no intended holding times. For example, if one had a given number of typhoid organisms in milk and wished to use heating times as short as 0.25 second with no intended holding time, one could determine from this research how high a temperature must be obtained by the milk to insure the elimination of all typhoid organisms.

Before this work could be done we had to develop a laboratory instrument to heat in these times and so designed as to insure an even and accurately controllable heating process. The instrument developed for these studies consists essentially of a stainless steel tank of five gallons capacity which is used as a reservoir for the inoculated milk under test. At the bottom outlet of the tank, a small bore stainless steel tube 10 feet in length is attached. Milk is forced through this tube by air pressure applied to the head of the milk in the five gallon tank. As the milk travels through the stainless steel tube, it is heated by heat transfer from the tube which in turn is heated by electrical resistance. The tube is heated by two separate and independent electrical circuits. The first part of this tube has been designated as a preheat section and is used to heat milk to 135°F. Research has shown that heating milk containing pathogens to this temperature in the short amount of time used in this system does not cause death of these organisms. The lethal portion of the heating cycle is done in the second section of this tube. This section is used to raise the temperature of milk from 135°F. to any desired temperature below its boiling point in heating times as short as 0.25 second. Samples are cooled either on glass beads which have been precooled in a freezer or when dilution can be used, in cold liquid bacteriological media or cold distilled water.

By using these methods cooling times are reduced to a minimum since the temperature in the collecting flask never reaches a lethal range. A holding time of 0.05 second was inherent in this process. Temperatures were obtained by thermocouples placed directly in the flowing milk. Temperatures were taken at the end of the preheat and heater section of the tube. The heating curve in the second section of the tube or the heater section was found to be linear.

Rennin coagulation studies were done as an indicator of what was done to the milk protein when milk is heated by this process. The results of this study are shown in Table I. Typically, raw milk has a longer coagulation time than that of milk which has been heated moderately. As the heating process becomes more severe the clotting time will increase and finally exceed that of raw milk. Results from this study indicate that this process does not severely alter the protein of milk.

Phosphatase studies were also performed when heating times of 0.50 and 0.25 second were used. These results are shown in Tables 2 and 3. It was found that average temperatures of 178.5 and 182.4°F. were required to reduce the phosphatase level to a standard of 2.3 micrograms of phenol. We also checked this heated milk for phosphatase reactivation which is a potential problem with this type of process. Twenty-four hours after samples were taken, the sample which showed 2.3 micrograms of phenol immediately after heating was rechecked for phosphatase. Results were erratic especially with the shorter heating time but do indicate that phosphatase reactivation will be a problem with a process involving as short heating and holding times as this one. Phosphatase reactivation is not a new problem and has been demonstrated by several investigators, notably Wright and Tramer in their series of publications on this problem.

The bacteriological studies done in this phase of the investigation involved finding the minimum final heating temperature which was adequate to destroy concentrations of approximately one million organisms per ml. of the milk under test. Results are shown in Tables 4 and 5. As can be seen from these tables, the most heat resistant organism worked with was Escherichia coli which required average final heating temperatures of 171.7 and 174.5°F. with respective heating times of 0.5 and 0.25 second. The relative lack of thermal resistance of these organisms was rather surprising. With the exception of Escherichia coli the final temperatures needed to destroy these organisms was in the general range of the standard H. T. S. T. process with the difference in these two processes being a much shorter heating and holding time in the experimental.

In addition to these, bacterial studies were also performed on the heat resistant organisms MS102, which Dr. Barber as well as others have worked with. Our primary interest in this organism was to compare its thermal resistance with some pathogens which may be found in milk. Table 6 shows the results of this study using 99.9% destruction as an endpoint. It must be emphasized that a considerably lower temperature would be necessary to achieve 99.9% than complete destruction with a starting inoculum similar in concentration to the bacterial studies mentioned previously. Complete destruction data was not obtained because final heating temperatures over the boiling point would have been necessary. MS102 was found to be considerably more heat resistant than any other organism we have data on.

Table 7 and 8 compare the 0.5 and 0.25 second experimental heating process with conventional vat pasteurization. It can be seen in Table 7 that a final heating temperature of 190°F. will give a process equivalent in lethality to 6.51 or 8.22 vat pasteurization processes depending on whether one uses a heating time of 0.25 or 0.5 second. These values were calculated using a z value of 9 as an average for vegetative bacterial cells. Similarly Table 8 shows that a final heating temperature of 190°F. in the experimental process is equivalent in lethality to 195.3 or 246.6 minutes at 143°F. when respective heating times of 0.25 and 0.5 second are used.

Since extinction data of this type are limited in their application, this study was enlarged to include thermal resistance studies when both long and short heating times were used. From these data one can construct thermal death time curves. These curves will show how long a process must be for any given processing temperature or conversely what processing temperature must be used for any given heating and holding time. In addition the scope of this research was enlarged to include studies on chocolate milk, 40% cream, and ice cream mix as well as fluid milk.

Two instruments were used in this phase of the study. One was the heat exchanger which has been described earlier. This instrument was used to obtain data for very short holding times. Since the heating curve of this instrument was known, values obtained from studies using a combination of heating and holding time were converted to holding time data. The other instrument was an accurate ($\pm 0.2^\circ\text{F.}$) water bath which was used to obtain data using relatively long holding times. The milk or milk product under test was placed in a 500 ml. three necked distilling flask and this flask was immersed in the water bath to a point one inch above the milk product level inside the flask. One side neck of

the flask was used to introduce a calibrated thermometer and the other side neck as a sampling port. The center neck was used to seat a motor driven stirrer. The milk was heated in the water to a temperature which was adequate to result in the desired exposure temperature after the inoculum was added to the test fluid. In other words, for an exposure temperature of 130°F. the milk was heated to 130.5°F., since it had been previously determined that inoculum would cool the milk 0.5°F. at this temperature. After inoculation had taken place, the water in the water bath was cooled 0.5°F. by the addition of ice water and the thermoregulator reset so as to maintain a constant temperature of 130.0°F. Sampling was done by an automatic pipette at preselected time intervals. Timing was done by a motor driven interval timer and samples were cooled by adding them to cold distilled water. Final numbers were determined by standard plate counting procedures.

D values and z values have been determined for Escherichia coli, Corynebacterium diphtheriae, and Shigella paradysenteriae when they are suspended in raw milk, chocolate milk, 40% cream, and ice cream mix. Studies on Staphylococcus aureus, Salmonella typhosa, and Streptococcus pyogenes, Influenza A and B, and the three types of polio are in progress. Since the D value indicates the time necessary to reduce the population of any given microorganism at a given temperature one log cycle, a single D value is not adequate to insure a safe milk. This suggests the general problem of how many D values should a process contain. It would seem to me that it would be highly improbable to get a concentration of greater than 1000 pathogenic organisms per ml. in a milk which appeared to be otherwise satisfactory. If one accepts the logarithmic theory of death, it is impossible to achieve sterility for any given organism initially present in the milk if an infinite quantity of this milk is available for processing. Therefore, one must set probability limits. It would seem to be that the chance of one organism surviving in a million ml. of processed milk might be a logical endpoint. Therefore, if one started with an initial concentration of 1000 pathogenic organisms of a species a process of 9 D values must be applied to reduce this concentration of pathogenic organisms to a theoretical one in one million.

On the basis of 9 D values being considered as a logical total process and on the further basis of the research on the organisms which has been completed, the standards of 143 or 145°F. for 30 minutes and 161°F. for 15 seconds are quite adequate for the production of a safe milk. These results also rather strongly suggest the possibility of a much faster process (eg. heating times of less than one second with no intended holding time) with final heating temperatures of well below 200°F.

Let me emphasize that these comments are based on the result of the work which has been done at the University of Massachusetts and, of course, may not apply to all pathogenic bacteria and virus which may be associated with milk. This research program will continue with other bacteria and viruses than those studied to date in an effort to give more complete data on this general problem.

Table 1

RENNIN COAGULATION
0.5 Second Heating Time

Temperature (°F.)	Clotting Time (Min.)
202.6	20
187.0	19
175.2	18
159.8	17
152.1	14
Raw	23
143°F. / 30 min.	14

Table 2

PHOSPHATASE DESTRUCTION
0.5 Second Heating Time

Temperature (°F.) for 2.3 micro gms.	24 hr. reading (micro gms.)
Range 176.9 to 179.8	0.5 to 5.5
Mean 178.5	2.7

Table 3

PHOSPHATASE DESTRUCTION
0.25 Second Heating Time

	Temperature (°F.) for 2.3 micro grms.	24 hr. reading (micro grms.)
Range	180.1 to 184.1	3.1 to 10.0
Mean	182.4	5.35

Table 4

TEMPERATURE REQUIRED FOR COMPLETE DESTRUCTION
0.5 Second Heating Time
0.05 Second Holding Time

	(°F.)
<u>E. coli</u>	171.7
<u>S. pyogenes</u>	158.9
<u>Sh. paradysenteriae</u>	162.0
<u>S. typhosa</u>	162.8
<u>C. diphtheriae</u>	157.4

Table 5

TEMPERATURES REQUIRED FOR COMPLETE DESTRUCTION

0.25 Second Heating Time

0.05 Second Holding Time

	(°F.)
<u>E. coli</u>	174.5
<u>S. pyogenes</u>	162.5
<u>Sh. paradysenteriae</u>	162.8
<u>S. typhosa</u>	165.1
<u>C. diphtheriae</u>	161.4

Table 6

TEMPERATURES REQUIRED FOR 99.9% DESTRUCTION OF MS102

With 0.25 and 0.50 Second Heating Time

Heating Time	Range	Mean
0.25 sec.	191.3 - 192.9	191.9
0.50 sec.	189.5 - 191.8	190.6

Table 7

TOTAL LETHALITY
143°F. for 30 minutes = 1 Unit

Final Temperature (°F.)	0.25 sec.	0.5 sec.
150	0.00038	0.00059
160	0.0039	0.0055
170	0.0411	0.059
180	0.510	0.626
190	6.51	8.22
200	71.40	101.0

Table 8

STERILIZING VALUES
Based on 143°F. for 30 Minutes

Final Temperature (°F.)	0.25 sec. (min.)	0.5 sec. (min)
150	0.0114	0.0177
160	0.177	0.165
170	1.23	1.77
180	15.3	18.8
190	195.3	246.6
200	2142.0	3030.0

BACTERIAL INACTIVATION IN MARKET MILK EXPOSED TO ULTRA-HIGH TEMPERATURES

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Intensive research data on ultra-high pasteurized milks are rather fragmentary. I will attempt to bring you up to date on what has been done, and what is being thought about, in the field of ultra-high temperature pasteurization of milk. I will try to think with you of some of the problems which will evolve as this product develops commercially.

We may as well realize that we are going to utilize ultra-high temperature processes to pasteurize milk. This type of process is definitely on its way, and even in commercial plants in certain areas at the present time. The entire trend in the industry is in this direction.

I think that we should take a look at the "why" this trend is developing. As you well know there is considerable consolidation of dairy plant processing into large operations. This is done to reduce labor costs, which is the largest cost item in processing. The reduction in labor costs is permitted by the effective use of automation and special equipment, which can be justified in larger operations. What are the implications of this consolidation into these larger operations?

First, a longer hauling of the raw milk; second, longer hauling of processed milk. Both of these mean that the product must have a longer shelf life. Another thing that is involved is the reduction of delivery costs. This can be realized in ultra-high temperature pasteurized milk, because, if we have a product with longer shelf life there can be more wholesale and retail outlets. I think the industry will go to bulk delivery of milk to homes, and cut down on the largest single cost of dairy plant operations, which is retail delivery.

There are a couple of other implications to consider with longer shelf life. It will be possible to preserve milk, as market milk, during months of peak supply for the times when the supply is lower. Furthermore, it will be possible to preserve the product better with higher temperatures of refrigeration in storage.

With this brief economic background, I think you can see that there are good reasons for heading in the direction of ultra-high temperature pasteurized milk, or more specifically, sterilized milk.

I would like to review with you some of our knowledge of the bactericidal heat treatments of milk. The normal pasteurization, of 143°F. for thirty minutes or 161°F. for sixteen seconds, is involved bacteriologically primarily with the destruction of pathogens. This is the main purpose of either heat treatment. Of course, along with this we destroy the faster growing types of bacteria which are found in raw milk. This latter result tends to prolong the shelf life of milk under refrigeration. In the normal pasteurization of milk, obviously, there still remain many surviving bacteria that can limit the shelf life of the product.

In recent years there has been developed an addition to holder and H. T. S. T. pasteurization treatments, the instantaneous pasteurization at 194°F. No time limit is set on this pasteurization procedure. Actually most measurements indicate that the product is at this temperature about three quarters of a second. Any practical measurements, of course, is out of the question and we say it is instantaneous heating at 194°F. This method has been expanded in usage after it had been proved that this exposure is at least as effective as holder or H. T. S. T. pasteurization techniques. Actually, it is more effective because it was shown to have a margin of safety above that normally obtained by the conventional methods of pasteurization. This method has been approved by the U. S. P. H. S. for about 5 years.

The bacteria that survive this treatment (194°F.) are primarily heat resistant micrococci, certain microbacteria (which incidentally are the most heat resistant non-spore forming bacteria that we know of) and bacilli or spore-forming bacteria. Even these surviving bacteria are somewhat impaired in their subsequent growth after such a heat treatment.

There are, therefore, two heat treatments customarily used in commercial pasteurization, viz., the holder and H. T. S. T. methods (which I consider essentially synonymous as far as their bactericidal effect is concerned). Then the other treatment is instantaneous pasteurization at 194°F.

These two general methods of pasteurization are of course widespread. The 194°F. pasteurization is commonly effected by such units as the Vacreator, Mallory, Roswell and others.

I would like to move on to what we can expect if we would heat milk in the range of 220°F. or 250°F. This is a common range in which ultra-high temperature pasteurization is presently being effected. At this temperature you will realize that milk is above the boiling point of water, and the milk is therefore under pressure. Heating is an instantaneous process. Surviving are the spore-forming bacteria. However, under refrigeration, which can be 50°F. instead of much lower (such as 35°F.) the product will have a shelf life of three to four weeks. This method of pasteurization is being used quite extensively, particularly in areas of the mid-west.

Another type of heating, which is not too common in this country as yet, is heating to 300°F. to 325°F. instantaneously. Equipment for such treatment is made by a Swiss concern and also by manufacturers in this country. In this heat treatment evidence indicates that the product is sterile. There is, however, the opportunity of having certain heat resistant spores to survive.

I would like, after having reviewed these methods of heat treatment with you, to go into a little more detail on what some of the bacteriological observations have been on the use of ultra-high pasteurization. Let us start with lower temperatures and then move upward. There has been some work done with pasteurization at 206°F. for three seconds. This work has been reported from Michigan by Dr. Kaufmann. Using the same milk supply, part of it was pasteurized at 206°F. for three seconds and the other part pasteurized at 176°F. for sixteen seconds. The milk pasteurized at 206°F., after eighteen days storage at 45°F., had a count of 3,000 bacteria per ml. That pasteurized at 176°F. for sixteen seconds, after sixteen days at 45°F., had 87,000,000 bacteria per ml. The data show the slower growth of surviving organisms after these two heat treatments:

Pasteurization Process	Bacteria Count After Days Storage at 45°F.			
	1	9	16	18
206°F. - 3 seconds	100	100	-	3000
176°F. - 16 seconds	20Ths.	55Ths.	87M.	---

In a letter he wrote to me recently, Dr. Kaufmann states that such a product pasteurized at 206°F. for 3 seconds has had a shelf life of about 30 days under refrigeration.

Moving to higher temperatures, some companies have felt that a magical temperature for ultra-high temperature pasteurization is 219°F. to 220°F., with no hold to about a one or two second hold. They think this treatment gives their best bacterial kill, with a very extended shelf life for the product of about three or four weeks under refrigeration. But exceptions always seem to arise as soon as a process is considered optimum. One equipment manufacturer wrote to us recently and said that in one area particularly, when one of their clients went to pasteurizing at 220°F., the pasteurized product spoiled more quickly than when it was pasteurized at 195°F. How could we explain this? The results of a bacteriological study showed that the causative organism was *Bacillus lacticum*, which I had never heard of, but nevertheless it was a bacillus, a spore-forming organism; that was the important thing. From what I knew about bacterial spores, it seemed that this processor was, at this pasteurization temperature, getting a heat activation of the spores, resulting in faster spore germination. The spores were surviving the pasteurization; when the product was cooled to normal room temperature or under, the spores were then capable of more rapid germination and resulting growth of the vegetative cells caused spoilage of the product. I have since checked with Dr. Harold Curran, of the United States Department of Agriculture in Washington, and he confirmed my thoughts on this cause of spoilage. There have been a number of studies showing this heat activation effect on spore germination.

Another pasteurization exposure which has been used is in the range of 220°F. to 250°F. I should mention that 232°F. for one second hold is being used commercially in Michigan. Here the Roswell heater particularly has been the one used; there is no reason why other heaters, such as the Mallory heater, could not be used also. In reports from Michigan on this pasteurization method it has been claimed that by storage of the product at 40°F. it has had a shelf-life of forty-six days, and maintained an excellent flavor during the entire storage period.

Still another pasteurization treatment which had been used is 285°F. for three seconds. This has been used primarily in some research at the University of Wisconsin, where studies have been made on the making of a sterile 3 to 1 milk concentrate. In this process the product is heated to 285°F. for 3 seconds before being condensed, then it is condensed, again heated to 285°F. for 3 seconds to sterilize, and then it is canned aseptically. This appears to give a sterile product.

However, reports have indicated that there have been cases where spore-former survivors have been found. It has been attributed to errors in processing. It has not been shown conclusively that the survivors, resistant spores, have survived this process.

Finally, there is a process for pasteurizing at 300°F. with only instantaneous holding. The first commercial process using this exposure was developed in Switzerland, and is known as "uperization". There is also equipment being manufactured in this country by which pasteurization at 300°F. can be accomplished. In this process the heating is accomplished by steam injection. A lot of the first cooling is effected by introducing the heated product into a vacuum, and effecting instantaneous cooling by vaporization of water. All the results which I have read on "uperized" milk indicate that the product is sterile. Apparently the 300°F., from all we know at the present time, will kill all of the organisms that might be in the milk including the spore-forming bacteria.

This is about the extent, in a brief way, of what I can tell you of the results available on ultra-high temperature pasteurized milk. But I think that there has been the attempt to accomplish sterilization of milk without realizing and knowing the practical problems which will be encountered. I am confident that there is going to be a number of them. As we head toward the production of sterile milk our problem, bacteriologically will resolve around the destruction of bacterial spores. We are going to be less concerned about pathogens surviving in any of these heat treatments. With your permission I would like to discuss with you what I think we are going to encounter from spores, and why.

First of all, as you may recall, bacterial spores are extremely heat resistant. Usually evaporated milk is heated to 238°F. to 245°F., for fourteen to eighteen minutes to obtain a sterile product. This is a rigorous heat treatment and is the reason that the product has the cooked flavor it possesses. I would like to point out that certain spores are capable of surviving 240°F. for three hours. That is extreme heat resistance. If many of such organisms get into milk I cannot see how we can ever hope to sterilize it and at the same time have a product that is edible.

In considering the resistance of spores, another thing we must realize is that their resistance does vary, depending on the type of nutrients that have been supplied to the vegetative cells as the spores have formed. Aging usually increases spore resistance, so that, if a lot of the aged spores get into the milk we can expect such milk to be harder to sterilize. The greater the number of spores that might be in the milk, the harder it is to kill all of them in that particular milk supply.

All of these considerations make the prediction of sterilization requirements for milk indefinite and very difficult. Usually sterilizing exposures required to kill a very heat-resistant test spore will suffice for most practical conditions, but an exceptionally resistant type will occasionally be encountered which can survive a presumably adequate treatment.

I would like to explain a few terms related to spores, etc., which I think sooner or later, you will encounter. We might as well get them clarified at this time since they are important to the subject I would like to discuss next. The process of sporulation in certain bacteria is the forming of heat resistant or otherwise resistant bodies called spores. When spores get back into favorable media, with favorable physical conditions they develop again into the type of cell (a vegetative cell) that produced them originally. We call this process germination. It is just as when seeds germinate and form a plant. The former is called germination of the spores. So there are two processes I would like you to have clear in your mind - sporulation means the forming of the spores; germination means the growth of the spore into the vegetative cell.

One of the things that might be possible as we go to sterilization of milk, is to consider means of lowering the resistance of spores; this can be done experimentally and may be accomplished practically.

What are some of the known ways in which spores can be made to have less heat resistance? One way is very well known. In fact it was being done for years in the evaporated milk industry, in the pre-heating treatment, without realization of what was being accomplished. This treatment "heat-shocks" the spores and tends to make them germinate more quickly. Furthermore this makes them less resistant to subsequent heating. In the evaporated milk industry it is quite customary to pre-heat the milk before condensing; it has been shown that this makes the milk easier to sterilize after condensing and canning.

It is quite possible to induce the spores to germinate without heat shock. Certain metallic ions as manganese, chloride, nitrate, phosphate, etc., will cause spores to have less heat resistance. I am not saying that any of these are practical at present. But some similar means of lowering spore heat resistance may be found. People in regulatory work should realize that the industry has a serious problem here. I am sure that research is going to tend to help us answer some of these questions on how to kill spores with more certainty.

In view of some of the present limitations on our ability to control the resistance of spores, and our ability to lower the resistance of spores, it may appear that the dairy industry is faced with a dilemma -- at least for the present. I think we will have to recognize a term called, "practical sterility." In other words we must realize that in the heat treatments that are currently available to the processing of milk, there is a good possibility that certain spores will be present. This situation we have in evaporated milk today. The few spores that do survive apparently in most cases have an inability to germinate and cause spoilage in the milk. It may be asked "how can this be?" If spores survive they certainly are going to germinate and grow into vegetative cells. This is not necessarily the case. In the first place, particularly in cans, we have an anaerobic condition under which these spore-formers probably will not germinate.

Furthermore, the usual temperature of storage of the milk is not going to permit the germination of the spores. The most heat-resistant spores are the spores of thermophilic bacteria. In order for these spores to germinate and then grow, the milk would have to be stored at temperatures of about 110°F. to 125°F. I do not believe we are going to provide heated rooms in which to store sterile milk! This is another factor that will tend to keep surviving spores from germinating in sterilized milk.

Certain English workers have shown that there are certain products formed in milk during sterilization that seem to have a very definite inhibitory property toward spore germination. Thus, spores that were heated to various temperatures were placed in sterile water and in sterile milk. In water the spores germinated at a lower temperature than in the milk. There appeared to be an inhibitory substance formed in the milk during high temperature heating that inhibited the germination of the spores.

The foregoing are examples of the basis whereby "practical sterility" may operate commercially with quite satisfactory results.

There is another factor in the resolving of our problems on ultra-high temperature treatment of milk. This concerns milk enzymes. There are a variety of milk enzymes present in milk. They seem to be inactivated by conventional pasteurization treatments, i. e., 143°F. for 30 minutes or 161°F. for 16 seconds. I am referring particularly to the enzyme phosphatase. However, there are certain enzymes which we know are not inactivated at these pasteurizing temperatures. Examples are certain oxidative enzymes, such as xanthine oxidase, which is very important in the formation of an oxidized flavor in milk; this enzyme is not readily destroyed by normal pasteurization. Proteinases, which are in milk, also are heat resistant. These enzymes can have a very deleterious effect on milk. Are these enzymes destroyed by the high temperatures (200°F. to

300° F.) which are being used in the ultra-high temperature pasteurization methods? There are no data I know of to answer such questions.

We do know that in milk and cream, which has been pasteurized at 194° F. for a temporary exposure, there seems to be a reactivation of the phosphatase. This also seems to be the case with even higher pasteurization temperatures.

It has been reported by the canning industry that peroxidase, which also is in milk, is reactivated after certain vegetables have been heated to very high temperatures, cooled down and then allowed to warm up slightly.

We do not know if there are other enzymes which show reactivation. If they are reactivated they may well be capable of causing some spoilage of milk.

There is one thing that I would like to speak of parenthetically. I think we should take a very objective look at the phosphatase test, particularly with respect to enzyme reactivation. I have a colleague, Dr. L. W. Aurand, who is an excellent biochemist; he is very interested in enzymes and has been working on xanthine oxidase particularly in its relation to oxidized flavor. He tells me that he has not yet seen the evidence to indicate that phosphatase or peroxidase actually is reactivated. What I am saying is that our tests for these enzymes involve the testing for certain products of enzymatic activity. We are not testing for the enzyme per se. My colleague feels that the tests, so far as concern the investigations made on the reactivation of the enzymes, have not proved conclusively to him that these enzymes are actually reactivated. Rather there may be some products formed in the milk during heating and, as a result of some non-specific action during storage, produce the so-called positive tests for phosphatase. This is a very brief resume of our reasoning, but I believe we have good basis for our doubts on the specificity of phosphatase tests in this regard. I think we have to realize that we have tests with limitation in their accuracy. We have to apply them with wisdom because of these limitations.

I would like to move on and speak of flavors in milk treated with the ultra-high temperatures. There seems to be some cooked flavor immediately after the products have been heated, but which, within about one to two days afterward, will dissipate. The slight cooked flavor that does result with the high instantaneous heat treatments appears not to be a serious problem.

The body defects that might occur, however, do still seem to be a problem. There are frequent instances when there is a separation of the

protein during the storage of the milk. I believe this can be overcome, but this is a real problem and it occurs within the sterile product.

Of course I think that one of the biggest problems that we are going to be concerned with in the shelf life of the sterilized products is the post sterilization contamination. After the product has been sterilized it will have to be handled under sterile conditions. This means use of sterile containers and that the filling operation will have to be done in a sterile atmosphere.

You may ask whether this can be done. There is equipment on the market now for canning sterile products aseptically. The Martin canner is one and there is a new one being developed. It will be used in conjunction with filling a paper container. We are getting one in our laboratories. There are, therefore, methods available for the aseptic canning or packaging of the sterile products.

In summary the status of the problem is as follows:

We have certain problems confronting us with milk products that have been heated to ultra-high temperatures in making them sterile, and then packaging them to maintain their sterility.

We have problems on the question of enzyme reactivation which needs to be settled.

There are certain body defects, which can be overcome, but here again research is needed on protein destabilization to provide badly needed fundamental information.

As far as the survival of pathogens is concerned, I have read nothing which would indicate that we have anything to worry about in ultra-high temperature heat treated milk.

About the future - we will need all the research we can get on how we can handle the spores that are in milk. This will involve the study of how to secure the lowest possible spore heat resistance so that the body and flavor characteristics of the milk are not impaired by excessive heat.

We are going to need research on the chemical products formed during the sterilization of milk, particularly those products that affect the flavors of milk. We have some information on this subject, but with studies done at lower temperatures than about which we are now thinking.

In spite of certain of these problems we all realize that the dairy industry has had many problems greater than these in the past and they have been overcome. I think the obtaining of a sterile milk, one that can be stored at normal room temperatures for six months, is just a matter of a very short time until we have it on a very satisfactory basis.

Question: What is going to be the role of the health department in the supervision of the sterilized milk as it develops?

Answer: I believe first of all we must realize that we are in a dynamic situation in the dairy industry, and in which constantly is presented new and different problems. For instance we now have the staphylococcus toxin problem. Here is one involving a product of bacterial activity, a product which is much more heat resistant than the bacteria which formed it. Certainly this is of importance in milk condenseries and dry milk plants. I think that we are going to have problems, but they will change from those that are bothering us now, such as total counts psychrophiles, coliforms, etc. I think less attention will be placed on these conventional tests, particularly on the finished product. We will have to take a new look at Nocardia-mastitis which is developing into more of a problem than we had realized from the one publication which has appeared on the subject.

One other thing that I did not mention in the talk. It seems to me that processors of ultra-high temperature pasteurized milk should consider heat activation of spores before the final sterilization process. I know as sanitarians we do not like to see milk heated a couple of times. However, this is being done already in the evaporated milk industry. Pediatricians recommend this product over market milk for infant feeding so we cannot really feel that it has any impaired nutritional value. I do not see any reason why the dairy industry should not consider this preheat treatment in an effort to activate spores before final sterilizing treatment is given market milk. None of the methods on the market at the present time do this.

Therefore, I think the efforts of the regulatory people might be directed to problems such as the foregoing ones.

Question: May not the health department or regulatory peoples' work be concerned primarily, in sterilized milk, in the handling of the product after packaging rather than in the processing of it?

Answer: I do not think so. The work of the regulatory people will be on the raw product. Supervision of the processing will also be needed.

I think once the product is in the can in a sterile condition you will not have to worry about it.

Question: You have spoken rather passively about pathogens in the ultra-high temperature treated milk. Is there really any justification for this passive interest? Has there really been any research done with actual pathogens?

Answer: Yes, to the latter part of the question. You will hear about it tomorrow from Dr. Litsky or Dr. Read. Rather than for me to tell you what he can tell you first hand, I would like to leave that to him. This is the primary work with which I am familiar. There has been studies done at Rutgers also. I must not forget Dr. Black and his group, who were concerned with collaborative work on Q fever at California in the survival of Coxiella burnetti.

Question: Since there seems to be very good evidence of phosphatase reactivation in ultra-high temperature pasteurized product, how are we going to reconcile this with supervisors, particularly in the medical profession, who are interested in products that give a positive phosphatase test?

Answer: We have to be flexible in our acceptance and in our use of the various tests. When we have a test that seems to give misinformation, there is no use of continuing to use this particular test. Please do not misinterpret me, for I am not an authority on the phosphatase test. We definitely know that these high temperatures will kill all pathogens within reasonableness and without any stretch of the imagination. This has been shown. Then, there are always records on pasteurization temperatures obtained which every company must keep. These records should be checked whenever a positive phosphatase test has been obtained. I do not know of any other tests right now.

There are certain efforts being made to detect the products being formed as the result of certain heat treatments. This may be another index that might be more reliable than the survival of that particular enzyme in milk. We will have to realize the limitation of these tests and use them with more discretion.

Question: When we first started using the phosphatase test back in 1934 in one instance at least, we had 47% of the milk under-pasteurized. If we are losing this test with the ultra-high temperature treatment, we certainly should encourage the research people to develop something to provide a tool to work with.

Answer: I have overlooked mentioning to you that this so called reactivation of the phosphatase occurs after the product has been pasteurized, cooled and then reheated. I know of no evidence, and I stand to be corrected, that if this product is kept cool, without rewarming, that you then get a reactivation of phosphatase. What I think is involved is a little more careful treatment of the sample; avoid rewarming before you run a phosphatase test. I have been involved in some arguments about sampling. I never have believed in taking samples from the delivery truck. I think samples should be taken from a source you can well control, namely the dealer's refrigerated storage. As the case is now, if I were a sanitarian, and know and believe in what I know now, I would not take any samples for coliform or otherwise, that I did not take right off the line after the filler. I am talking about samples that I would take into the laboratory, the results of which might be used in court testimony. I would, therefore, in the present situation with ultra-high treated milk, if I wanted to know that the milk was being pasteurized thoroughly as far as the phosphatase enzyme is concerned, get a container of the freshly heat-treated product. Then I would avoid warming the refrigerated product before doing the test to avoid some of these anomalies that apparently exist about reactivation. I do not believe in just fighting these anomalies that we know exist. Rather I would try to realize the limitations of the test and work within these limitations.

Dr. Barber do you wish to comment?

Dr. Barber: We have never had a positive reaction when the sample has been kept cold. It is only when the sample has been warmed up that this reactivation takes place. We have found that this warming up has been very critical. When your technician in running the various tests, places the milk bottle on the table and allows it to stand for 30 minutes to an hour, then there is a good possibility of a false phosphatase test showing up. If he takes the test immediately while the sample is still cold, with no chance to warm up, he has no difficulty.

I have a few points I would like to throw out here. There is work going on to determine a better procedure for determining whether or not the product has been properly pasteurized. As you know there are two phosphatases in milk - alkaline phosphatase, which is normally used in our phosphatase test and there is an acid phosphatase. Preliminary work has shown that the acid phosphatase requires higher heat treatments to activate it so it would be more applicable to your higher heat treatment processes. So far, in the few tests that have been run, there is no evidence that this acid phosphatase undergoes a reactivation. So work is being done. I think eventually we will come up with an answer and give you

fellows a test by which you can determine if the milk is properly pasteurized.

Question: While the answers to the problem of testing for phosphatase will be forthcoming, I am wondering, if you found a bottle of milk at a retail outlet that was positive to the phosphatase test, if the answer or check would not be the plate count for this ultra-high temperature treated milk?

Answer: No, I do not think so. Plate counts are not effective. What you would need would be a mass inoculation of the product into a medium that would support the growth of any bacteria that might be present.

Comment:

Dr. Luther Black: I would like to open a discussion of the chemical sterilization of milk.

Mr. McLean: I would like to ask as to what has happened to the Flager's method of adding hydrogen peroxide. The milk is first heat shocked, then hydrogen peroxide added, then going on up to 260°F. to 300°F. Has any work been done on this?

Dr. Speck: I am not familiar with that. Do you have a comment Dr. Barber?

Dr. Barber: This process was considered under the sterile products at one time. I understand it is being reactivated. It has its drawbacks along with some of the other chemicals we have to contend with.

Mr. McLean: There are various methods and means of so-called shock heating or heating milk which have not been resolved either. There is the process of direct injection of steam and thereby adding chemicals. You heard Mr. Ramsey of the Food and Drug Administration say that there is a zero tolerance of added chemicals. On the other hand there are other methods of heating such as the Roswell.

Dr. Speck: Speaking on this problem or method of steam injection, I do not know how one can effectively test for boiler compounds that might come through with the steam. It has been our experience that you can put steam purifiers in the line, which from anything we have been able to determine, allow no residual to come through. Furthermore, I

think further work can be done on boiler compounds. I hope the sanitarians will take a long serious look at steam injection before it would be disallowed. This method has excellent possibilities. We are convinced from our work on foreign flavor removal that heat from steam injection looks quite different from heat by transfer through a metal plate. There are certainly commercial advantages for the flavor of the products by direct steam injection. Industry is doing what it can to use steam injection prudently.

PASTEURIZATION CONTROLS IN RELATION TO INACTIVATION OF PATHOGENIC MICROORGANISMS

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Pasteurization of dairy products has long been accepted by Regulatory Officials and the Dairy Industry as a process which will provide the consuming public with a safe product. The main objective of pasteurization, as is well known, is the destruction of all pathogenic organisms which might be present in or which might get into milk or other dairy products. Although there is no doubt as to the safety of our pasteurization processes, it is well occasionally to review the information available and determine the progress that is being made in providing the public with safe wholesome products.

The trend today in the processing of dairy products is toward higher temperatures and shorter times of treatment. Improvements in equipment and controls are making these new processing treatments possible. Since equipment and controls are becoming more and more precise, the determination of the adequacy of a process with respect to the destruction of pathogens becomes the determination of the minimum time and temperature required for the complete destruction of the pathogenic organisms.

The majority of the early literature related to the establishment of pasteurization standards was concerned with the question of whether or not the pasteurization treatment destroyed certain pathogens and not with the problem of the minimum time and temperature which would accomplish this destruction. This type of approach was completely satisfactory as long as only one combination of time and temperature was practiced; but, when higher temperatures and shorter times of processing were desired, additional bacteriological information was needed. There is still a need for the determination of the minimum temperature with no measurable hold time at which pathogenic organisms are killed in various dairy products, not because there is any question as to the safety of present day processing treatments, but because this type of information will be of great value in aiding in the establishment of standards for new and improved processing treatments.

For a better understanding of the reasons for the above suggestion, let us review some of the literature available on the destruction of various organisms by pasteurization treatments. The organisms in which we are interested at present are Mycobacterium tuberculosis, Salmonella paratyphi A and B, Bacillus typhosus, Corynebacterium diphtheriae, Brucella abortus, Coxiella burnetii, hemolytic streptococci, and the poliomyelitis viruses.

Before a critical review of the literature is undertaken there are a number of points which should be mentioned so that the results reported can be better understood. A cold reporting of facts gleaned from the literature might result in a confusing compilation of information. Figures alone cannot be used, but rather a careful study of the conditions of the experiments is needed.

It must be remembered that the early studies on the destruction of pathogens by pasteurization were designed to show that the process actually resulted in a product that was noninfectious. In many of the early reports no mention was made of the numbers of the organisms present in the inoculated product. Frequently actual measurement of the time of processing was not possible and again, while the time was constant for a series of treatments, only a few temperatures were studied. Hence, when considered in the light of our present day knowledge, many of the early reports leave much to be desired in the way of complete information. What can be gained from the early literature is a general picture of the destruction of pathogens by pasteurization with the more precise information regarding actual thermal death times yet to be obtained.

Mycobacterium tuberculosis. This organism was considered as the most heat resistant of any pathogen which might be found in milk. Consequently the early investigators felt that if this organism was destroyed by the pasteurization process other pathogens also would be destroyed. A vast number of studies were made investigating the destruction of the TB organism by pasteurization. A search of the literature disclosed over 100 references reporting all kinds of time and temperature combinations from a low temperature of 130°F. for 60 minutes to a high temperature of 174-176°F. for 13.6 seconds. In many instances the combinations reported were not actual thermal death times, but were the time and temperatures at which no growth of the organism was detected in the pasteurized product after a series of different heat treatments. Although these early studies showed conclusively that pasteurization at 143°F. for 30 minutes would give a safe

product, comparatively little of the data are of value in evaluating higher temperatures and shorter times. A few of the many time-and-temperature combinations reported in the literature are shown in Table 1.

Salmonella paratyphi A and B, Bacillus typhosus, Corynebacterium diphtheriae and hemolytic streptococci. These organisms are less resistant to heat than the TB organism, and there are fewer references in the literature to studies concerned with their destruction by pasteurization treatments. Here again we find reports of these organisms being killed in 10 minutes, but not in 5 at various temperatures rather than exact time-and-temperature combinations. However, in practically all instances these organisms were reported as being destroyed by lower temperatures and shorter times than those recommended for pasteurization of milk, cream or ice cream. Table 2 summarizes some of the data available for the destruction of B. typhosus or Eberthella typhosa as it was formally called, in milk, cream and ice cream. Table 3 summarizes examples of data for several other pathogens.

It should be noted that Tables 2 and 3 include data reported by Litsky and his co-workers at the University of Massachusetts. These workers are obtaining the more exact type of information that is needed regarding the destruction of various microorganisms. Their laboratory equipment is such that inoculated product can be heated rapidly to comparatively high temperatures, and immediately cooled so that the "hold-time" at these temperatures is in fractions of a second. It is this kind of information that enables us to be certain that our new pasteurization treatments are more than adequate. More of this type of information is needed on other pathogenic organisms.

Brucella abortus. The Brucella are another group of organisms which have received considerable attention with respect to combinations of time and temperature needed for their destruction. The examples included in Table 4 show fairly good agreement between workers. A low temperature of 125°F. for 30 minutes and a high temperature of 174-176°F. for 13.6 seconds are the extremes which have been reported.

Rickettsia (Coxiella burnetii) and Viruses. These infectious agents have been investigated more recently than the other organisms we have been discussing. Extensive research has been carried out at the University of California at Davis on the thermal inactivation of Coxiella burnetii, the Rickettsia causing Q fever. These studies have been complete and exact and resulted in the recommendation by the U. S. Public Health Service in 1956 that pasteurization of milk at 145°F. for 30 minutes or 161°F. for

15 seconds is adequate to protect the public health against these organisms. An additional 5°F. of temperature is suggested for dairy products containing higher fat or added sugar.

The most extensive work on the destruction of viruses, particularly the human poliomyelitis virus and the Coxsackii virus, has been reported by Kaplan and Melnick. These workers have shown that these viruses are destroyed by the presently accepted pasteurization treatments. Time-and-temperature combinations for milk, cream and ice cream, which resulted in no infectivity are shown in Table 5.

Pasteurization Standards. At the present moment the accepted pasteurization standards for milk are 143°F. for 30 minutes and 161°F. for 15 seconds. Ice cream pasteurization standards vary from section to section of the country, but for the most part the recommended standards are 155°F. for 30 minutes, 175°F. for 25 seconds, 194°F. for the Vacreator, and 200°F. for 3 seconds. Recently there has been proposed a series of intermediate pasteurization standards between the long hold process of 155°F. for 30 minutes and the high temperature-short time process of 175°F. for 25 seconds.

When pasteurization standards are proposed, the question arises as to methods for the determination of the adequacy of pasteurization. Ideally the method would involve the addition of the most heat resistant of the pathogens to the dairy product, pasteurization at the desired time-and-temperature and the determination that none of the added organisms are recoverable. There is understandable reluctance toward the use of pathogenic test organisms either in a milk plant or in a research laboratory unless unusual facilities are available. Hence the supporting research for a new pasteurization process, for the most part, has utilized non-pathogenic test organisms whose resistance to heat is greater than that of the most resistant pathogen.

There are numerous reports in the literature concerned with the use of a heat resistant test organism in the evaluation of various pasteurization treatments. These data were used as a basis for the establishment of the 175°F., 25-second standard for ice cream pasteurization. Recently (during the last two or three years) these data were also used in support of the intermediate pasteurization treatments mentioned earlier. A part of this presentation involved the graphic presentation of the data and resulted in a graph showing that the proposed pasteurization processes resulted in heat treatments and bacterial destruction comparable to or better than that obtained by the presently accepted pasteurization treatments.

For the purpose of this discussion a graph (Figure 1) has been prepared showing the present standards for pasteurization of milk and ice cream. These standards result in straight lines on the graph. Also shown on the graph are the data summarized in Tables 1-5. It is interesting to note that all the early results on the destruction of pathogenic organisms in milk, cream or ice cream mix give points that are well below both of the pasteurization curves or lines shown on the graph. This can be considered as graphic evidence that present day pasteurization processes will result in products which are safe and free from pathogenic bacteria.

In summary this presentation has been a brief review of the voluminous literature on the destruction of various pathogenic organisms by pasteurization treatments. There is no question regarding the safety of our pasteurization processes, and it must be said that the early investigators gave us a good basis for the establishment of these standards. As newer equipment becomes available and the industry looks to higher temperatures and shorter times of processing, the bacteriologist must continue his efforts to determine the temperature with no holding time which will completely destroy all pathogenic organisms. It is realized that this is a difficult assignment, but eventually the necessary information will be obtained. In the meantime, present day pasteurization processes give adequate control of the healthfulness of our dairy products.

Table 1

DESTRUCTION OF MYCOBACTERIUM TUBERCULOSIS IN DAIRY PRODUCTS

<u>Temperature</u> °F	<u>Time</u>	<u>Product</u>	<u>Worker</u>
130	60 min.	milk	North and Park (48a)
134	40 min.	milk	North and Park (48a)
135	20 min.	cream	Oldenbush et al (50)
136	30 min.	milk	North and Park (48a)
137.8	30 min.	milk	North et al (49)
138	20 min.	milk	North and Park (48a)
140	10 min.	milk	North and Park (48a)
140	15-20 min.	milk	Smith (from (41))
140	20 min.	milk	Rosenau (from (41))
140	20 min.	milk	Park (52)
142	10 min.	milk	North and Park (48a)
145	6 min.	milk	North and Park (48a)
145	6 min.	ice cream	Oldenbush et al (50)
149	31 sec.	milk	Lear et al (41)
150	3 min.	ice cream	Oldenbush et al (50)
150	2 min.	milk	North and Park (48a)
152.6	15 sec.	milk	Lear et al (41)
153.9	12.5 sec.	milk	Holmquist (from (41))
155	30 sec.	milk	North and Park (48a)
156	5 sec.	milk	Lear et al (41)
158	16 sec.	milk	Mattick and Hiscos (43)
158	2.2-3.7 sec.	milk	Weber (81)
160	15 sec.	ice cream	Bundesem et al (17)
164	no hold	milk	Holland and Dahlberg (33)
174-176	13.6 sec.	milk	Seeleman (58)

z value - 7.0 and 6.9°C. - Ball (3)
 4.9°C. - Lear et al (41)

Table 2

DESTRUCTION OF EBERTHELLA TYPHOSA IN DAIRY PRODUCTS

<u>Temperature</u> °F.	<u>Time</u>	<u>Product</u>	<u>Worker</u>
135	10 min.	cream	Oldenbush et al (50)
140	5 min.	cream	Oldenbush et al (50)
140	7.5 min.	milk	Tanner and Dubois (71)
142	3 min.	cream	Oldenbush et al (50)
143	2 min.	cream	Oldenbush et al (50)
145	2 min.	cream	Oldenbush et al (50)
145	5 min.	ice cream	Oldenbush et al (50)
150	5 min.	ice cream	Oldenbush et al (50)
158	2.2-3.7 sec.	milk	Weber (81)
162.7	0.5 sec.	milk	Litsky (42a)
167.2	0.25 sec.	milk	Litsky (42)

z value = 15.3°F. - Ball (3)

Table 3

DESTRUCTION OF OTHER PATHOGENS IN DAIRY PRODUCTS

Shigella

<u>Temperature</u> °F.	<u>Time</u>	<u>Product</u>	<u>Worker</u>
162	0.5 sec.	milk	Litsky (42a)

B. paratyphosum A

140	10 min.	milk	Tanner and Dubois (71)
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B. paratyphosum B

140	7.5 min.	milk	Tanner and Dubois (71)
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B. dysenteriae

140	10 min.	milk	Tanner and Dubois (71)
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Streptococci (pathogenic)

135	5 min.	cream	Oldenbush et al (50)
145	1 min.	cream	Oldenbush et al (50)
145	5 min.	ice cream	Oldenbush et al (50)
150	5 min.	ice cream	Oldenbush et al (50)
158.4	0.5 sec.	milk	Litsky (42a)
160.8	6 sec.	milk	Weber (81)
162.7	0.25 sec.	milk	Litsky (42a)

B. diptheria

145	0.5 min.	ice cream	Oldenbush et al (50)
188.8	0.5 sec.	milk	Litsky (42a)
192.0	0.25 sec.	milk	Litsky (42a)

Table 4

DESTRUCTION OF BRUCELLA IN DAIRY PRODUCTS

<u>Temperature</u>	<u>Time</u>	<u>Product</u>	<u>Worker</u>
<u>Br. abortus</u>			
125	30 min.	milk	(Evans) Foster et al (25)
140	10 min.	milk	(Park) Foster et al (25)
140	15 min.	milk	Boak and Carpenter (14)
140	20 min.	milk	(Carpenter & Boak) Foster et al (25)
142	7.5 min.	milk	(Park) Foster et al (25)
142.7	23 min.	milk	Foster et al (25)
145	5 min.	milk	(Park) Foster et al (25)
145	30 sec.	milk	(Evans) Foster et al (25)
149	4 min.	milk	Foster et al (25)
160	21 sec.	milk	Foster et al (25)
161.6	14 sec.	milk	Foster et al (25)
174-176	13.6 sec.	milk	Seeleman (58)
<u>Br. suis</u>			
140	20 min.	milk	Park et al (53)
142	15 min.	milk	Boak and Carpenter (14)
142	15 min.	milk	Park et al (53)
144	7 min.	milk	Park et al (53)

Table 5

DESTRUCTION OF VIRUSES AND RICKETTSIA IN DAIRY PRODUCTS

Human poliomyelitis

<u>Temperature - °F.</u>	<u>Time</u>	<u>Product</u>	<u>Worker</u>
143	15 min.	ice cream	Kaplan and Melnick (35)
160	15 sec.	ice cream	Kaplan and Melnick (35)
143	30 min.	cream	Kaplan and Melnick (35)
160	15 sec.	cream	Kaplan and Melnick (35)
131	15 min.	milk	Kaplan and Melnick (35)
160	7.5 sec.	milk	Kaplan and Melnick (35)
149	30 min.	ice cream	Byrd (18)

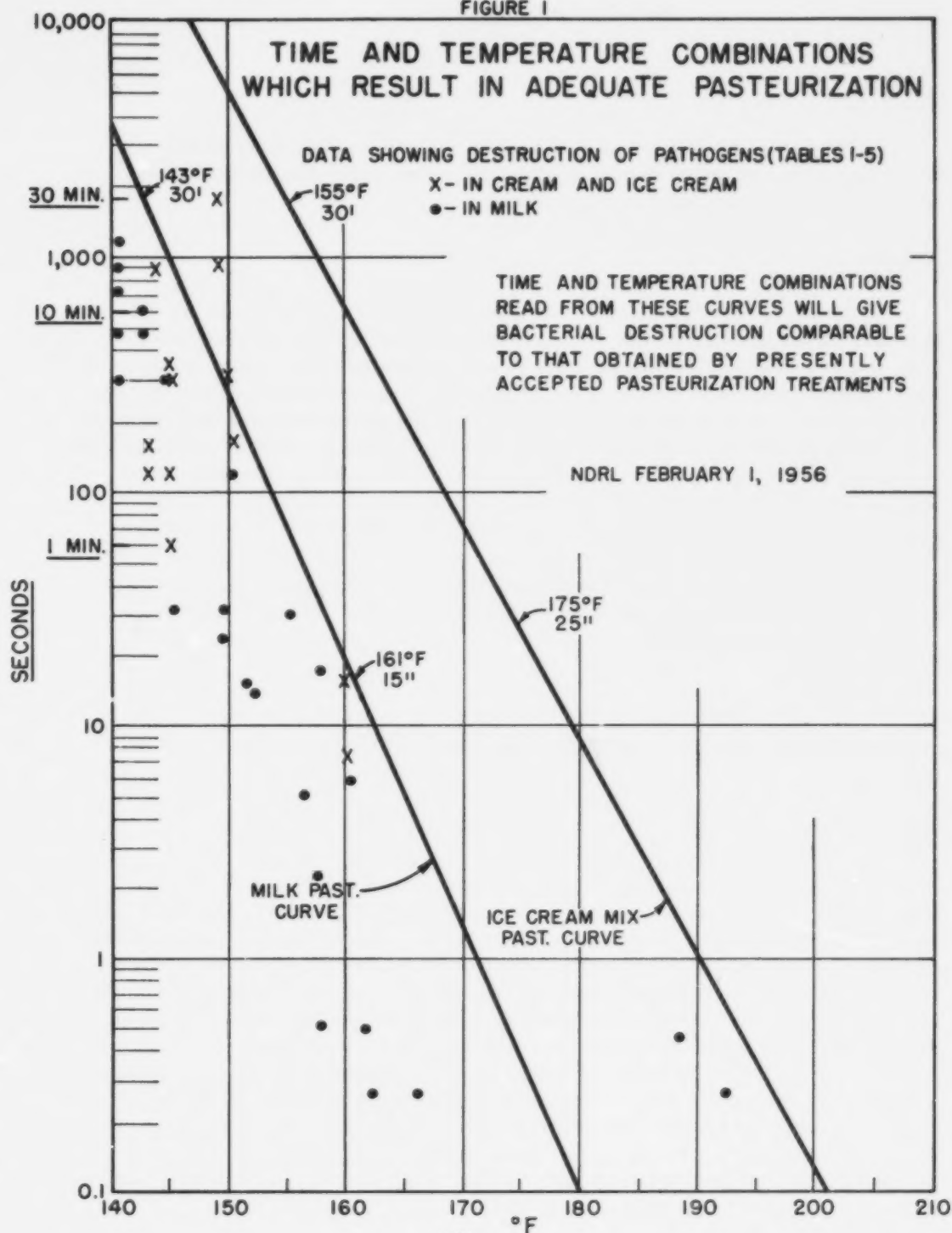
Coxsackii virus

<u>Temperature - °F.</u>	<u>Time</u>	<u>Product</u>	<u>Worker</u>
149	15 min.	ice cream	Kaplan and Melnick (36)
160	7.5 sec.	ice cream	Kaplan and Melnick (36)
143	30 min.	cream	Kaplan and Melnick (36)
160	7.5 sec.	cream	Kaplan and Melnick (36)
143	15 min.	milk	Kaplan and Melnick (36)
160	7.5 sec.	milk	Kaplan and Melnick (36)

Coxiella burnetii

<u>Temperature - °F.</u>	<u>Time</u>	<u>Product</u>	<u>Worker</u>
143	30 min.	milk (1,000 doses)	Enright et al (23)
144	30 min.	milk (10,000 doses)	Enright et al (23)
144	30 min.	milk (1,000,000 doses)	Enright et al (23)

FIGURE 1



Audience Participation

Question:

How does it happen that the data for the destruction of the polio organism in milk does not give the same type of curve that is shown for the pasteurization curve?

Answer:

In the study designed for the destruction of polio in milk, the primary interest was in the temperature of 160°F. for 15 seconds. This was to make sure that the H. T. S. T. standard took care of that particular organism. This is an objection I have to much of the early work. Here one temperature was run and the time interval of taking the samples was such that the exact destruction time at that temperature could not be determined. This means that at the time shown here of 160°F. for 7 1/2 seconds, the seven and one-half seconds was the shortest time at which the investigators were able to take the sample. The results were negative. Possibly, if other temperatures that were lower were used data would be obtained that would give a straight line curve. This would also show that the 7.5 seconds was off the curve.

Question:

Do you think it is sound procedure to project a curve through only two points and assume that all the rest of the points will fall on that curve?

Answer:

No, I don't! Actually, we drew this line for the milk curve through the two points. In endeavoring to draw the line for the ice cream curve, we had points for every temperature that we have shown across the bottom of the chart. I indicated when I first spoke of this curve, this is not the curve we had from the data we obtained, because another safety factor of a large number of seconds was added to it by selecting 175°F. for 25 seconds. Actually the curve upon which our ice cream data was based is closely parallel to the milk curve. Since 175°F. for 25 seconds has been accepted as a safe pasteurization temperature, we always report our results as bacterial destruction comparable to or better than the destruction obtained at 155°F. for 30 minutes. Returning to your question, Mr. Colvin, in drawing any curves for these organisms we definitely want more than two

points. Usually in the laboratory there are a half-dozen or more points. For all the organisms we have studied, destruction time and temperature combination all fall on or below this line.

I might add another interesting point. In some of our early work on these heat resistant test organisms, we found that when the higher temperatures and shorter times were reached the curve dropped off. The curve was not a straight line curve when we reached temperatures above 170°F. to 175°F., but it began to fall off more sharply.

By extrapolating the curve on a straight line relationship, we have more safety built in on time-and-temperature combinations.

Comment from Dr. Speck:

I think it is appropriate to mention that this 194°F. for a fraction of a second was established for ice cream mix. The curve will show that there is added a margin of safety over the 155°F. for 30 minutes. This 194°F. for instantaneous heating of less than a second has also been one that has been used for milk, so we have a much larger margin of safety. It may also be brought out that 155°F. for 30 minutes was never established as being necessary. It was established from practice because it was necessary to heat the ice cream mix up to this temperature for a period of time in order to have the mix in proper condition to homogenize. There is no scientific basis upon which to base the thought that this temperature is necessary. In fact to destroy phosphatase you need only five minutes at 155°F.

Dr. Barber:

I might add another point that has not been discussed; with the Roswell heater, for example, the temperature of 200°F. for 3 seconds has been talked about. This is also a time-and-temperature combination that is applied to both milk and ice cream mix. The time interval is one that was picked out of the air. You can see from the data on the chart that 200°F. for three seconds is more than adequate to take care of anything we might worry about. The three seconds was selected because we had to have a measurable time. With the automatic equipment that was available at the time this work was being done, three seconds was about the shortest possible time we could measure with any degree of accuracy. I think we are safe in saying, due to the work Dr. Speck has done, that any temperature above 194°F., with even no hold at all, is going to be adequate to destroy these pathogenic organisms.

Question:

Is it not true that 192°F. for one second is being considered from a legal or regulatory standpoint? Would this time-and-temperature be adequate, and would we have controls to take care of this time element on market milk?

Answer:

I would think that 192°F. for one second would take care of the pathogenic organisms. I might say here that the measurement of the three seconds was selected some four or five years ago. The advances that have been made today in controls and devices for measuring short periods of time have come a long way; it may be possible to time for one second now.

Comment from Dr. Speck:

The time-and-temperature of 194°F. for 3/4 of a second that was established for ice cream mix has a margin of safety added to it. The temperature that was actually required for this very heat resistant organism in ice cream mix was 191.5°F. These organisms were added to the ice cream mix; we do not normally like to do this. We put the mix through the Vacreator; and the experiments, which were repeated a number of times, showed at 191.5°F. for less than a second was all that was required to destroy this heat resistant organism MS. 102.

Question:

We see that 192°F. or 194°F. is more than adequate in temperature even with no hold. Thinking of the control system we are using now with the recorder-controller sensitizing bulb located immediately upstream from the flow diversion valve, in many cases within three or four inches, let us assume we have a heat failure in the heater. Can we not have a rapidly descending temperature? On the basis of the fact that we have about a two and one-half second delay in the response time in our controller and the diversion of the flow diversion valve, in this two and one-half second delay and the rapid descending temperature on an ultra-high temperature when the velocity and quantity is high, would it not be possible to get some sub-temperature milk into the forward flow?

Answer:

I wish I had brought some additional data with me. This question has been raised in New York City on the annular film heater. A series of studies were made in which we simulated all types of conditions including power failure, steam loss, and things of that sort.

I recall that the drop of temperature was not fast enough to cause any under-pasteurized product to be in the final product before diversion took place.

Comment from audience:

We added an additional factor in that in case of a loss in steam pressure there was an automatic milk pump stop.

Comment from audience:

Why have a pressure stop and a temperature stop on the annular film heating system now? It is on the high side, which will take care of that two and one-half seconds. You have two steps so you can divert, on either side. Even if you divert the pump will stop.

Comment from audience:

You have a lot more heat residual in the annular film heater than you do on the plate heat exchanger, so your descending temperature would be less on the plate type than the annular film heater.

Comment from audience:

One way that this can be controlled, although the Standard Ordinance and Code does not permit it, is to change the location of your sensitizing bulb.

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STATE EVALUATION AND SURVEY PROGRAMS

One of the Components of a Cooperative Program for the Procuring of Milk and Milk Products for Federal Government Installations

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I. Introduction

1. The making of regular evaluations and surveys of local milk sanitation programs is a traditional and valuable service of State Health Departments. These surveys, made according to the uniform milk sanitation rating procedures developed by the Public Health Service, give numerical estimates of the extent to which the local pasteurization plants, raw milk supply, and enforcement procedures comply with recognized standards. These numerical estimates - or ratings - show the percentage compliance found as compared with the ideal of 100 percent. Ratings of 90 percent or higher indicate satisfactory conditions and programs.

Milk sanitation surveys are useful in several ways, including:

- a. The Health Director in charge of the local public-health program is given a technical appraisal of his milk sanitation program.
- b. Interstate shipment of high-quality milk is facilitated.
- c. Inter-county shipment of high-quality milk is facilitated.
- d. Information is made available for those responsible for obtaining high-quality milk for Federal government installations.

- e. Finally, the surveys are a definite stimulant of high-caliber performance by milk sanitarians, as well as milk plant operators and dairy farmers.
2. If milk sanitation surveys are to serve these purposes adequately, it is essential that the surveys be accurate and reliable, and that all parties concerned accept the survey information as being accurate and reliable. The over-all title of this panel discussion includes the words "..... a Cooperative Program....." Cooperation implies and requires mutual understanding and confidence. In this presentation I hope to show that State milk sanitation survey programs, properly done, merit such confidence, and provide accurate and reliable information. In order to do this, I shall attempt to describe the program of the State with which I am most familiar - North Carolina - and a program which I believe now deserves to be ranked in the 90 percent bracket.

II. North Carolina Milk Sanitation and Survey Activities

1. In North Carolina, local health departments began milk sanitation work around the time of World War I. Milk sanitation became a definite program in the State Board of Health in 1924. Initial efforts included promoting municipal adoption of the PHS Milk Ordinance in the interest of uniformity, and the making of surveys to encourage effective enforcement. At present, the Ordinance is in effect, in the form of rules and regulations adopted by country or county-district boards of health, in all but three of the 100 counties of the State. Enforcement is done by the sanitarians employed in the county health departments. The North Carolina Board of Agriculture also has adopted State-wide milk regulations based upon the United States Public Health Service Milk Ordinance.
2. A special study was made of the milk sanitation activities of local health departments for the year 1955¹, and a summary is given in Table I:

¹Because of changes in annual report forms, for local health departments, similar data will soon be available for 1958 and succeeding years.

Table I

**Milk Sanitation Activities of North Carolina
Local Health Departments During 1955**

<u>Activity</u>	<u>Retail Dairies</u>	<u>Plant Producers</u>	<u>Pasteurization Plants</u>
Field visits	650	32,885	4,270
Official inspections	422	27,776	802
Degradings	5	554	19
Legal actions	1	11	2
Samples collected	668	50,300	12,940
<u>No. Dairies & Plants</u>	<u>68</u>	<u>5,200</u>	<u>98</u>

3. It was estimated that the local health departments spent more than \$300,000 on milk sanitation work during 1955, a figure which is 0.6% of the value of the raw milk taken as \$50,000,000. More than 100 of our local sanitarians do some milk sanitation work.
4. In the State Board of Health we now have three District Milk Sanitarians and a Supervisor of Milk and Shellfish Sanitation. Counting time spent on milk matters by the Section Chief, and Division Director, we have the equivalent of slightly more than four full-time men on milk. With this staff functioning throughout 1958 for the first full year, our program for that year showed a definite improvement over the previous year. In 1958, 15.8% of our Sanitation Section staff time was spent on milk, as compared with 9.6% in 1957. During 1958, 58 milk sanitation surveys were made and a total of 2015 inspections of dairies and plants were made. Twenty-nine North Carolina milk plants are included in the January 1, 1959 edition of the interstate milk shippers list issued by the Public Health Service. We have begun some educational activities, and hope to do more in the future. A Policy and Procedure Manual letter spells out the more important policies and procedures observed and followed in milk sanitation activities.
5. Turning to the technical and practical aspects of the program,

our three District Milk Sanitarians are well qualified; all have had considerable local health department experience, and two have had industry experience also. All have been certified by the Public Health Service as milk sanitation rating officers. Before beginning a survey, the District Milk Sanitarian writes the local health department a few days in advance. The District Milk Sanitarian makes a random selection of the plant producer dairies to be inspected, rides with the local sanitarian to make the inspections (sometimes accompanied by the dairy plant field man), inspects the milk plants during operation and also after breakdown for cleaning, checks the local records, and records bacteria counts and temperatures. The District Milk Sanitarian fills out a field data sheet, fills out survey forms in pencil, drafts a narrative report, and transmits these, together with copies of all inspection sheets, to the Supervisor of Milk and Shellfish Sanitation at the Raleigh office. There the transfers of violations from inspection sheet to survey form are checked, pro-rating formulas are verified, and rating calculations are made and checked. After verification by the Supervisor, survey sheets are typed, checked and photostated, narrative reports are typed, and the photostat and narrative are sent to the Local Health Director with an appropriate letter of transmittal. Copies are sent routinely to the chief local milk sanitarian, District Milk Sanitarian, and the Regional Office of the Public Health Service. Where indicated by notations on the field data sheets, Interstate Milk Shipper Report forms are prepared and processed.

6. Milk sanitation survey reports are regarded as technical reports to the Local Health Directors on their milk sanitation programs. Copies of reports are not sent direct to industry; when requests are received from industry, we refer the inquirer to his Local Health Director. Rating figures are supplied, upon request, to other counties in which the local plants distribute milk. Consideration is being given to the publication of all survey ratings periodically in the monthly Health Bulletin of the State Board of Health.
7. To comment briefly on the milk survey program in general, we believe our surveys are accurate and reliable, that they are generally accepted as such, and we know they are effective in promoting needed improvements in programs and in the conditions maintained in dairies and plants.

III. Cooperation In Milk Procurement

1. It appears to me that civilian health agencies and those responsible for the milk supplies for Federal installations have similar interests, and that there already exists a very effective basis for cooperation. Federal installations procure grade A pasteurized milk as defined in the Milk Ordinance recommended by the Public Health Service. Local and State health departments are interested in seeing that dairies and plants comply with the sanitation standards of that ordinance. In the majority of cases, milk plants recognize the importance of living up to these standards and publicly acknowledge that high sanitation standards form the foundation of the modern dairy industry.
2. Data from State health department milk sanitation surveys should be of considerable help to officials of Federal installations. Milk plants bidding on Government contracts can get current milk ratings from their local health departments and submit these with their bids. If the Federal installation wants to verify the ratings, we are glad for them to check with us. Also, of course, ratings for many milk supplies appear in the Interstate Milk Shipper lists.
3. When check inspections are made by a Federal agency representative, the local health department would be glad for the local milk sanitarian to go with him if desired. If special problems arise in which our District Milk Sanitarians can be of help, we are glad to arrange for such help.
4. Whether or not there is need for more effective cooperation between Federal installation officials and State and local health officials in milk procurement, I am not in position to say. I can say, however, that our State and local health departments and their milk sanitarians have worked hard and conscientiously over a period of many years in the interest of safe, high-quality milk for the public, that we have accumulated a good deal of information and experience, and are glad to do our part in a cooperative program.
5. With the type of information which is now available from our routine milk sanitation surveys, it would seem to me that there is far less need now than there once was for the Federal installations to do independent field inspections and that there is more to be gained by having a good working relationship between the Federal installations and the State and local health departments.

ANIMAL DISEASES TRANSMISSIBLE TO MAN

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The interrelation of human and animal disease is probably as old as the origin of man, presuming that most of the animals were here before man. All pathogenic micro-organisms are biologically adventuresome in their struggle to survive - they must find a host. The broader the host range the easier their survival. As the host range of animal pathogens expands, they become a threat to man's well-being. This is well illustrated by many diseases which at one time were primarily identified with wildlife and now have been able to adapt themselves to domestic and pet animals. Leptospirosis and rabies are examples. Both of these diseases have a sylvatic reservoir and are frequently found in wild animals - occasionally they are transmitted directly to man, but rabies and leptospirosis are a much greater threat when they are established in farm or pet animals which have close contact with man.

The total number of infectious diseases that plague domestic animals is in excess of 200. The 1959 WHO Expert Committee on Zoonoses¹ lists more than 100 diseases which are common to man and animals. If one considers the emerging zoonoses (recently identified virus diseases of animals that are closely related to similar entities described in man); the possible size of the reservoir of diseases in the animal kingdom broadens. New disease entities or previously unsuspected human-animal disease relationships are being reported with increasing frequency . . . Why is this occurring? No one can give a complete answer but there are many factors at work, the most important being the constant change of host-parasite environment interactions.

The great changes in human and animal ecology which result from the agriculture and industrial development of new territories, as well as old, throughout the world have brought man into contact with animals and disease agents with which he may have had little or no

experience. Certain of these are periodic epidemic diseases such as the arthropod-borne encephalitides, epidemic hemorrhagic fever and fevers of undetermined etiology (FUE), many of which are known or suspected of having an animal reservoir. Most of these are sporadic diseases that become epidemic or epizootic in their proportions when susceptible human and domestic animal populations reach a critical level.

Human populations have been increasing at an accelerated rate since 1945. Animal populations likewise have been growing rapidly in the United States and most parts of the world. The tabulation in Table I gives an approximation of human and animal populations for the year 1956.²

It is anticipated that these populations will continue to grow. To develop the food animal resources needed to provide a standard of living comparable to any of the advanced western countries will require a three-to four-fold increase in their numbers. The control of old and new diseases in this population will be a task with which all branches of medicine, public health and agriculture will be concerned.

Zoonoses

The number of zoonoses (diseases of animals communicable to man) exceeds 100. (Table 2.) These can be classified by the nature of the agent, i. e., virus, rickettsia, bacteria, fungus, protozoa and helminth. Man may also become infested with various animal ectoparasites, e. g., aberrant mites, fleas, ticks and fly larvae. The list of zoonoses in Table 2 presents many interesting subjects, but because of the time limit only a few of the more important ones will be discussed.

Rabies

Rabies is always of concern to medical practitioners. This is not because of the number of human cases which fortunately has declined steadily in the past decade, but because of the management and treatment of the estimated 2,500,000 individuals who are bitten or scratched by animals each year. Out of this number an estimated 30,000 to 40,000 persons are bitten by rabid or suspected rabid

animals and must undergo the often painful and sometimes hazardous course of treatment.

To further illustrate the size of the animal bite and rabies problem, and accident survey by the California Health Department³ in 1955 revealed that animal bites comprise 2.6 percent, or an estimated 231,000 of non-fatal accidental injuries. While not all of these bites were reported to local health departments for investigations, a great number were of sufficient concern to the bitten individuals and their physicians to be so reported. For example, in Los Angeles County during 1955, 38,783 animal bites were reported to the six local health departments. Some 80,870 field visits were required in follow-up investigations of the 21,319 bites in the Los Angeles County Health Department jurisdiction alone. At least 1,001 persons in the county were known to have received anti-rabies treatment during the year. During 1955, 219 cases of animal rabies, 218 in dogs and one in a cat, were diagnosed in this area. Carithers,⁴ in a 20-month study of mammalian bites of children, points out that 15.4 percent or one in seven children between one and 10 years of age have been bitten at some time by a mammal, usually a dog, and 2.1 percent has been bitten more than once. Children, like young animals, are more susceptible to rabies. More than 50 percent of the fatalities from rabies which have been reported and studied in the past two decades have occurred in youngsters under age 15.⁵ Table 3 illustrates this succinctly.

What can be done to control or eradicate rabies as a public health problem? Rabies control is based on a trilogy of public health education, canine antirabies vaccination and animal control. Public health education is essential in any disease control program. The community must accept the concept that rabies can be controlled and eventually eliminated. Dog vaccination has been most successful where the community has been apprised of its merits in controlling dog rabies. Canine antirabies immunization is practiced with both phenolized brain tissue vaccine, a modified Semple-type vaccine, and the modified live vaccine which is grown in chicken embryos. Research carried on at the U. S. Public Health Service's Communicable Disease Center⁶ demonstrated the value of both vaccines when administered intramuscularly. The phenol-treated vaccine gave good immunity for at least two years, and the chicken-embryo live virus vaccine for more than three years. Canine immunization with live virus vaccine is thought to offer good protection for life, but animals that are in enzootic areas especially where wild animal or sylvatic rabies exists should be revaccinated periodically. The use of modified live virus vaccine has increased

steadily. In 1958 more than 4,000,000 doses were used compared to less than 3,000,000 of the killed vaccine. In 1945, more than 8,500 cases of dog rabies were reported. Since then dog rabies has declined steadily to a low of less than 1,700 cases in 1958. (Table 4.) This decrease is attributed largely to public acceptance of canine vaccination and improved rabies control programs in health departments. During this same period, sylvatic rabies has increased from 376 reported cases to more than 2,100, a six fold rise. Since 1945, the United States dog population has increased from less than 12,000,000⁷ to more than 25,000,000 in 1957.⁸ If canine rabies had increased accordingly, more than 18,000 cases would have occurred in 1957.

Animal control is the third phase of a rabies program and is mainly concerned with stray dog elimination in urban areas and wildlife reduction in sylvatic rabies areas. The ratio of dogs to humans varies from 1:5 to 1:10 in urban areas with the national average being 1:7. About 20 percent of this population are strays. A large number of these are eventually found by the dog warden and many returned to their owners. A surprising number are killed by automobiles. Recent surveys indicate about 25 percent of the total dog population is under one year of age and that the overall canine population control methods are now being studied - no doubt good licensure and registration can help. But indiscriminate breeding of unwanted puppies should be discouraged. Dog castration and spaying is to be recommended. A neutered animal, be it dog or cat, is usually a much better pet and is less likely to stray.

The treatment of human rabies has advanced considerably in recent years with the development of hyperimmune antirabies serum and new type immunizing agents. The WHO Third Report on Rabies⁹ reviews the value of hyperimmune serum and recommends its use in severe bites, especially in regions of the head. In their report, the Rabies Expert Committee recommends that treatment of all bite wounds especially those inflicted by animals suspected of being rabid, should consist of thorough cleansing with soap or a detergent solution. The committee further recommends that wounds not be sutured immediately as there is some evidence that the closure of a wound is a contributing factor to the development of rabies. Following completion of local treatment of the wound, infiltration of antirabies serum into the tissue beneath the wound when possible is considered to be effective in prevention of rabies. As you well know, some individuals are very sensitive to serum of horse origin and should be tested for sensitivity before it is administered.

The application of ordinary antiseptics and local or parenteral use of antibiotics have no prophylactic value against the rabies virus, but may follow the local treatment to combat bacterial infections.

The type of antirabies vaccine used in post-exposure treatment varies in different states and countries. In the United States a Semple-type vaccine made from heat inactivated phenolized rabbit brain tissue, an ultraviolet irradiated rabbit-brain vaccine and a duck-embryo vaccine inactivated by beta-propiolactone are used. These vaccines must meet the stringent requirements of the Public Health Service.

The WHO Rabies Committee has prepared a guide for specific post-exposure treatment. (Table 5.) This guide covers many situations in which an individual may be exposed to a rabid or suspected rabid animal.

Rabies prophylaxis in man has long been a special problem among certain groups of individuals with unusually high risks of reported exposure such as veterinarians, dog wardens, postal and delivery men, and laboratory workers. In these groups repeated exposure means repeated treatment, thus increasing the possibilities of severe reaction to the vaccine. Studies to determine the value of immunization of man against rabies before exposure have been inaugurated in many areas with state and local veterinary medical groups. High egg passage chicken-embryo vaccine and duck-embryo vaccine are being administered interdermally in a series of three inoculations five days apart. Preliminary results are encouraging as measured by the antibody response in the vaccinated individuals.

Q fever

Q fever is an example of the rickettsial diseases of animals that affect man. It has worldwide distribution. It is estimated that millions of animals are infected and in turn become carriers. The infection seldom produced recognizable disease in cattle, sheep or goats, the species known to be most frequently infected. Besides these food animals, various small mammals and rodents, and wild and domestic birds have been described as being susceptible to infection and capable of becoming carriers. In some parts of the world ticks are known to be transmitters of the disease.

The disease in man varies considerably in its behavior. In aged persons it may be generalized and terminate fatally. Most of the time when it is diagnosed, Q fever manifests itself as an influenza-like syndrome characterized by sudden onset, headache, malaise, and

thoracic pain. X-rays of the lungs reveal a patchy infiltration which frequently clears up in a few days. In many instances the disease can be diagnosed only by serological tests. Fortunately, the disease in man responds very well to the broad spectrum antibiotics.

The transmission of Q fever usually occurs by direct animal-to-man contact. It is most frequently encountered in persons who have been working around infected animals which contaminate the environment with the infectious agent especially at parturition and immediately thereafter. The disease is also seen among persons handling animal products, e. g., wool handlers, rendering plant and packing house employees. It has been described among military personnel in World War II in Greece and Italy and more recently in North Africa and Great Britain. In England and Wales it has been observed that the disease is seldom diagnosed in rural residents, but sporadic cases are seen in individuals who spend their holidays in these known enzootic areas. The disease is seldom spread from man to man although such instances have been described among troops, nurses and orderlies attending patients, and, in one instance, in a pathologist who was performing an autopsy. Occasionally the organism, Coxiella burnetii, is found in milk. C. burnetii is moderately hardy but proper pasteurization of milk will destroy the organism.⁸

The control of Q fever is difficult. Vaccination of certain high risk occupational groups is considered to be of some value. Immunization of cattle has been demonstrated experimentally to be effective. The proper pasteurization of all milk and milk products is an important phase of prevention. The appearance of the disease in barnyard fowl in Europe raises further problems in control.

Bacterial Diseases

The bacterial zoonoses were among the first diseases identified as being communicable, e. g., anthrax, brucellosis, glanders, bovine tuberculosis and salmonellosis. These diseases, along with bacterial food poisoning organisms, were recognized early as public health problems; and this resulted in organized efforts by public health authorities and animal disease control officials to eliminate them insofar as possible. Animal anthrax has been drastically reduced and brought under control in most areas of the United States, although it is a disease which requires constant vigilance. The incidence among rural populations in the U. S. has declined concurrently with that in animals. However, in some parts of the world it still remains a problem. From

these areas occasionally contaminated goat hair, wools, hides and bones have carried infection to other countries and resulted in the spread of disease among man and animals. Fortunately, anthrax in man and animals responds in most cases to broad spectrum antibiotic therapy.

Fifty years ago glanders was a serious occupational disease among veterinarians, livery stable attendants and farmers, and frequently terminated fatally. This was one of the first animal disease transmissible to man to be brought under control in the United States and western Europe. With the rapid decline of the horse population, glanders has disappeared in both man and animals. But as is often the case, elimination of one communicable pathogen invites an antigenically related one in its place. In this instance it is pseudoglanders which was first described in rodents in southeast Asia and later in mules and troops during World War II in that area. It now has been reported in other areas of the world, presumably carried by rats. As with many of the diseases that have been mentioned, glanders and pseudoglanders respond to antibiotic therapy.

Brucellosis is probably the most widespread of the world's zoonoses. The number of human infections that occur in the world are estimated in the hundreds of thousands. In 1945, the total number of infections in man in the western hemisphere was thought to be almost 100,000. As recently as 1947⁹ it was estimated that more than 10,000 cases of human brucellosis were being diagnosed in the U. S. The infection rate in cattle at that time was estimated at 20 to 30 percent and in swine 5 to 10 percent. The incidence among goats and sheep was low. Since then a national campaign to eradicate brucellosis has been gathering momentum with support from the medical professions, public health agencies and agriculture services. In 1958 less than 800 human cases were reported, most of which were caused by occupational exposure occurring among veterinarians, farmers and workers handling animals and animal products. Veterinarians and meat inspectors continue to have the highest rate of infection. The incidence among dairy and range cattle has dropped precipitously. By the end of 1958, 16 states were accredited by the national brucellosis control program - which means that less than one percent of their cattle show a positive serum agglutination. It is anticipated that more than one-half the states will be accredited as modified certified bovine brucellosis free by 1960. The swine problem will now receive more attention and eventually it should be eliminated, as will the disease in

goats. Sheep brucellosis was never a disease entity of any consequence in the United States, although it is a major animal and human health problem in the U. S. S. R. In southern Europe, Africa and Asia goats are the main source of human brucellosis. Dr. Karl F. Meyer, who is a world authority on animal diseases and comparative medicine, is leading the fight against goat brucellosis as a consultant to the WHO. The Meyer-Elberg vaccine is being used to immunize goats on nearly every continent where Brucella melitensis is a problem.

As to treatment of brucellosis in man, it responds to the broad spectrum antibiotics; but relapses are not infrequently reported. One of the peculiar facets of the disease is the hypersensitivity to the brucella organisms that occurs in some individuals following the acute clinical stage. This is seen among veterinarians and research workers especially - and in some instances it requires that they change their type of practice or work. When these individuals come in contact with live or dead brucella organisms, they immediately develop signs of acute disease. Removal from contact with the organism clears up the signs, but they frequently recur.

The over-all prospect for eradication of brucellosis in the United States is good and will certainly be achieved in the next decade. But as always, there is a new disease to replace those that are brought under control. Leptospirosis is an excellent example. Twenty years ago leptospirosis was only identified with rats and as Weils' disease in man. About that time Meyer and his colleagues¹⁰ reported on a new form of leptospirosis in man, Canicola fever, which was transmitted from dogs. Since then the number of serotypes of the *Leptospira* have risen from three or four to more than fifty. Leptospirosis has been reported on every continent and in nearly every country of the world. Today it is one of the most widespread diseases in nature and has been found in all kinds of animals: cattle, swine, horses, cats, dogs, rodents, skunks, racoons, foxes and even birds. The disease in animals may vary from an asymptomatic transitory infection to a very severe form with high fever, prostration and hemorrhages throughout the body followed by early death. Uremia is seen in those cases with extensive kidney damage. In less acute cases, icterus and hemorrhages are common. The disease in cattle is characterized by hemoglobinuria, diminished lactation and abortion in pregnant animals. The organism often localizes in the kidney, and animals will remain carriers for long periods after recovery.

Leptospirosis in man is usually an occupational disease, but it may be a recreational accident. The disease in the former group, as would be expected, is most frequent among those working with animals, followed by general agriculture workers, and abattoir employees. Veterinarians, dog handlers, breeders and pet owners occasionally are infected. Small outbreaks have been reported among swimmers or those enjoying water sports and recreation.¹¹ It has also been an important military disease among troops. Infection in man occurs either directly from urine or tissues of a diseased animal or indirectly through contact with water or soil contaminated by animals. The leptospira enters the body usually through the externally accessible mucous membranes or abrasions of the skin.

Symptoms of leptospirosis in man vary. Although they are frequently severe, the mortality rate is low. The disease is manifested by fever, headache, myalgia, and meningitic signs. Jaundice is seldom seen except in severe cases. Agglutinins for leptospira appear 7-14 days after onset and reach maximum titers several weeks later. Recently Galton¹² of the Public Health Service has developed a multiple antigen which is now being used for serological screening tests. This method is now being evaluated in health departments, hospital laboratories and veterinary diagnostic centers. The organism has often been isolated from the blood during the febrile period of the disease and from the urine during convalescence.

Therapeutic procedures vary in man and animals as do the results. Penicillin, streptomycin, aureomycin and terramycin are all effective prophylactic agents but relatively ineffective therapeutic agents unless given early in the course of the disease.¹³ Some investigators believe there is considerable variation in the susceptibility of certain strains to antibiotics which may account for their effectiveness.

Control of leptospirosis in animals is most difficult. The broad host range, the carrier state in recovered animals, the contamination of water and soil, the survival of the organism under adverse environmental conditions all are problems that must be overcome. Vaccines for animals and man are being developed and field tested. Vaccines are now available for dogs and cattle in the United States. The problem of the wildlife reservoir is one that is being studied in many countries. At the moment vaccines in man and animals offer the best solution to control.

Fungal Diseases

Ringworm of animals is often the cause of similar infection in children and occasionally in adults. In urban communities Microsporum canis, the common cause of dog and cat ringworm, is the principal cause of animal ringworm in man. In rural areas, Trichophyton verrucosum, the cattle ringworm, and T. mentagrophytes, which is a common cause of ringworm of rodents, are the main animal fungus infections affecting man. The transmission of the disease to man occurs by close contact. The cuddling and handling of pets is common among children as well as adults, and it is obvious that the infection can be easily transmitted. Occasionally the handling or petting of a stray cat or dog may be the only contact.

The cattle infections are usually transmitted to man as occupational exposures during the winter months. Farmers and their families become infected when handling animals at milking time or contacting the fungus in the barn. Although ringworm in man and animals is of worldwide occurrence, there are few data available on its morbidity. In the U. S. some large urban outbreaks among children were attributed to M. canis. The control of these infections in children must be based on the elimination of the animal disease. Stray animal control of cats as well as dogs is basic. In some cases where the animals do not respond to therapy especially in kittens or puppies, it is best to remove them from the household. The diagnosis of the disease in man as in animals is based on examination with the Wood's light apparatus and microscopic examination of suspicious skin lesions and hair. Culture of skin scrapings and hair are used for more precise diagnosis of species involved.

Cattle ringworm is a winter disease especially among animals kept in barns most of the day. The disease will often clear up spontaneously when warm weather returns and the animals return to pasture. Most of the human infections are seen in the winter, and frequently they clear up when the animal infections disappear. Therapy in both man and animals is not always successful and requires patience and experience on those attending the patients or clients. A new antibiotic, GRIFULVIN, that has been used in treating plant diseases has given excellent results in animals and is now being used experimentally in man.

Parasitic Diseases

The list of animal parasites that affect man and animals is considerable. (Table 2.) Not all of these occur in the United States, and even those that are found are in limited numbers except for some of the dog and cat hookworms (Ancylostoma braziliense) and around worms (Toxocara canis and T. cati) which cause cutaneous larva migrans (creeping eruption) and visceral larva migrans respectively. The cutaneous infection results when the dog or cat hookworm larva enters the skin of man and begin wondering about aimlessly because they are in a foreign host. The dog and cat roundworm eggs when accidentally ingested by man, usually children, hatch out in the intestine. After entering the portal circulation they may cause damage to any organ that they may enter which in some cases may lead to death.

Fortunately, the beef and pork tapeworms, which are serious problems in man in some parts of the world, are relatively rare in our country - largely because of the competent meat inspection services provided by the U. S. Department of Agriculture and good rural hygiene practices which prevent the return of the parasite to its intermediate host: cattle or swine. We are even more fortunate that the dog tapeworm, Echinococcus granulosus is relatively unknown in the United States. This is the parasite that causes hydatidosis in man and food animals. In South America, Australia, North Africa and southern Europe it is a major public health problem. Control is dependent on drastic dog reduction, and sanitary packing house and rural slaughter practices which prevent dogs from eating diseased viscera.

Trichinosis is still a problem in the States - about one fourth of one percent of the grain-fed swine and considerably more of swine fed raw garbage are estimated to be infected. The cooking of garbage has cut incidence of infection in them, but there are still some infected swine which find their way to market. To add to the difficulty of control, recent studies have revealed that wild animals are frequently diseased and that swine become infected when they ingest rodents or other diseased animals. The wild animal reservoir extends into the Arctic where polar bears, foxes, walruses and even whales have been found to have trichinosis.

Summary

The animal kingdom is large - its numbers reach into the billions. The diseases to which animals are susceptible are many; and,

as we have seen, a good portion of them are transmissible to man. Some of the serious animal diseases which have not, thankfully, found their way to man include: rinderpest, hog cholera, canine distemper, canine hepatitis, avian leukosis, heartworm and many others. Some of the degenerative or chronic diseases of animals are similar to those of man and offer excellent opportunities for comparative epidemiological studies. These include many types of tumors, cardiovascular diseases, diabetes, and other degenerative entities.

The investigations of some of these spontaneously occurring chronic diseases in animals are already turning up interesting findings that will be of value in the conquest of these problems in man's eternal struggle for better health and a better world.

The control, elimination and eradication of some of the more important communicable diseases of man and animals have now been achieved to a degree in the United States and some of the advanced western nations. This knowledge is being extended to other countries in helping them to a more healthful life. The control of diseases like rabies, brucellosis, bovine tuberculosis, tapeworms and other parasites will add immeasurably to the well-being of the world's peoples.

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TABLE I
HUMAN AND ANIMAL POPULATION
In Millions

	<u>Human</u>	<u>Cattle*</u>	<u>Sheep</u>	<u>Swine</u>	<u>Goats</u>	<u>Horses, Mules and Donkeys</u>
Europe	412	107	129	95.2	21.6	20.1
USSR	210	65	118	51.1	19.3	16.2
North America	245	134	39	69.6	14.2	14.2
South America	129	147	121	47	21.6	26.4
Asia	1538	280	177	112.7	165.5	36.2
*Buffalo		90				
*Camels		3				
Africa	220	101	133	4.2	90.6	13.8
*Buffalo		1.7				
*Camels		6.4				
Oceania	15	22	170	2.3	.2	1
World	2769	957	887	382.1	333.0	127.9
GRAND TOTAL	Animals - 2,687 excluding poultry, dogs, cats, etc. Humans - 2,769					

TABLE 2

SOME DISEASES NATURALLY TRANSMITTED
BETWEEN VERTEBRATE ANIMALS AND MAN1. VIRUS DISEASES

<u>Disease</u>	<u>Causative Organism</u>	<u>Principal Animal Involved</u>	<u>Locale</u>
Arthropod-borne virus infections			
Colorado tick fever	Colorado tick fever virus	rodents	Western U. S.
Eastern equine encephalitis	Eastern equine virus	birds, equines	Eastern U. S.
Encephalomyocarditis	Encephalomyocarditis virus	rodents	Eastern U. S.
Japanese B encephalitis	Japanese B virus	birds, horses, swine & other mammals	-----
Murray Valley encephalitis	Murray Valley virus	birds	-----
Rift Valley fever	Rift Valley virus	sheep, cattle	-----
St. Louis encephalitis	St. Louis virus	birds	U. S.
Tick-borne spring-summer group (including louping-ill, Russian spring-summer encephalitis, Omsk hemorrhagic fever, Kyasanur forest disease)	Russian spring-summer louping-ill group of viruses	goats, sheep	-----
Venezuelan equine encephalitis	Venezuelan equine virus	birds, wild mammals	-----
Wesselsbron fever	Wesselsbron virus	equines, rodents	-----
Western equine encephalitis	Western equine virus	sheep	-----
		birds, equines	U. S.

West Nile fever	West Nile fever virus	birds	-----
Yellow fever (Jungle)	Yellow fever virus	monkeys	-----
Aujeszky's disease (pseudorabies)	Aujeszky's virus	ruminants, swine, dogs	U. S.
B virus	B virus	monkeys	U. S.
Cat scratch disease	Unknown	cats	U. S.
Cowpox (milker's nodule?)	Cowpox or vaccinia virus	cattle	U. S.
Equine infectious anemia	Equine infectious anemia virus	equines	Eastern U. S.
Foot-and-mouth disease	Foot-and-mouth disease virus	ruminants, swine	-----
Influenza	Influenza virus Type A	swine, horses	U. S.
Lymphocytic choriomeningitis	Lymphocytic choriomeningitis virus	mice, dogs, monkeys	U. S.
Newcastle disease	Newcastle disease virus	chickens	U. S.
Ovine pustular dermatitis	Ovine pustular dermatitis virus	sheep, goats	U. S.
Psittacosis (ornithosis)	Psittacosis virus	psittacines, poultry, pigeons	U. S.
Rabies	Rabies virus	dogs, cats, wolves, foxes, jackals, bats, other wild animals	U. S.

Sendai virus disease	Sendai virus	swine, rodents	-----
Vesicular stomatitis	Vesicular stomatitis virus	equines, cattle, swine	Eastern U. S.

2. RICKETTSIAL DISEASES

Murine (endemic) typhus	<u>Rickettsia typhi (mooseri)</u>	rats	U. S.
North Queensland tick typhus	<u>Rickettsia australis</u>	bandicoots, rodents	-----
Q fever	<u>Coxiella burnetii</u>	cattle, sheep, goats, wild and domestic birds and mammals	U. S.
Rickettsial pox	<u>Rickettsia akari</u>	mice	Eastern U. S.
Scrub typhus (Tsutsugamushi)	<u>Rickettsia tsutsugamushi</u>	rodents	-----
Spotted fever (including Rocky Mountain, Brazilian and Colombian spotted fevers)	<u>Rickettsia rickettsii</u>	dogs, rodents, and other animals	U. S.
Boutonneuse fever	)		
Kenya typhus	)		
also probably Indian	)		
tick typhus and South	)		
African tick-bite fever	)		
	<u>Rickettsia conorii</u>	dogs, rodents	-----

3. BACTERIAL DISEASES

Anthrax	<u>Bacillus anthracis</u>	ruminants, equines	U. S.
Brucellosis	<u>Brucella abortus, Br. suis.</u> <u>Br. melitensis</u>	cattle, swine, goats	U. S.
Bacterial food poisoning	<u>Salmonella spp., staphylococcal enterotoxin, Clostridium welchii, and others</u>	ruminants, swine, poultry	U. S.
Colibacillosis	<u>Escherichi spp.</u> Arizona group of Enterobacteriaceae	poultry, swine, dogs	U. S.
Erysipeloid	<u>Erysipelothrix rhusiopathiae</u>	swine, poultry, fish	U. S.
Glanders	<u>Actinobacillus mallei</u>	equines	-----
Leptospirosis	<u>Leptospira spp.</u>	rodents, dogs, swine, cattle	U. S.
Listeriosis	<u>Listeria monocytogenes</u>	rodents, sheep, cattle, swine	U. S.
Melioidosis	<u>Pseudomonas pseudomallei</u>	rodents	-----
Pasteurellosis	<u>Pasteurella multocida</u>	mammals, birds	U. S.
Plague	<u>Pasteurella pestis</u>	rodents	Western U. S.
Pseudotuberculosis	<u>Pasteurella pseudotuberculosis</u>	rodents, cats, fowls	U. S.

Rat-bite fever	<u>Spirillum minus</u> <u>Streptobacillus moniliformis</u>	rodents rodents	U. S.
Relapsing fever (endemic)	<u>Borrelia spp.</u>	rodents	Western U. S.
Salmonellosis	<u>Salmonella spp.</u>	mammals, birds, poultry	U. S.
Staphylococcosis	<u>Staphylococcus spp.</u>	mammals	U. S.
Streptococcosis	<u>Streptococcus spp.</u>	mammals	U. S.
Tuberculosis	<u>Mycobacterium tuberculosis</u> var. <u>bovis</u> var. <u>hominis</u> var. <u>avium</u>	swine, cats, cattle goats. dogs, swine, monkeys poultry, swine, cattle.	U. S. U. S. U. S.
Tularemia	<u>Pasteurella tularensis</u>	rabbits, hares, sheep, wild rodents	U. S.
Vibriosis	<u>Vibrio foetus</u>	cattle, sheep	U. S.
<u>4. FUNGUS DISEASES</u>			
Ringworm, favus	<u>Microsporum spp.</u> <u>Trichophyton spp.</u>	dogs, cats, horses horses, cattle, poultry, small mammals	U. S.

5. PROTOZOAL DISEASES

Balantidiasis	<u>Balantidium coli</u>	swine	U. S.
Leishmaniasis			
Espundia, American leishmaniasis	<u>Leishmania braziliensis</u>	dogs, cats, rodents	-----
Kala-azar	<u>Leishmania donovani</u>	dogs, cats, rodents	-----
Oriental sore	<u>Leishmania tropica</u>	dogs, cats, rodents	-----
Toxoplasmosis	<u>Toxoplasma gondii</u>	mammals, birds	U. S.
Trypanosomiasis			
African sleeping sickness	<u>Trypanosoma gambiense</u>	wild and domestic ruminants	-----
Chagas' disease	<u>Trypanosoma rhodesiense</u> <u>Trypanosoma cruzi</u>	wild game cats, dogs, rodents	U. S.

6. HELMINTH DISEASES

(a) <u>Trematode diseases</u>			
Amphistomiasis	<u>Gastrodiscoides hominis</u>	swine	-----
Clonorchiasis	<u>Clonorchis sinensis</u>	dogs, cats, swine, wild mammals, fish	-----
Dicrocoeliasis	<u>Dicrocoelium dendriticum</u>	ruminants, equines	-----
Echinostomiasis	<u>Echinostoma ilocanum</u> (and occasionally other species)	cats, dogs, rodents	-----

Fascioliasis	<u>Fasciola hepatica</u> <u>Fasciola gigantica</u>	ruminants ruminants	U. S.
Fasciolopsiasis	<u>Faciolopsis buski</u>	swine, dogs	-----
Heterophyiasis	<u>Heterophyes heterophyes</u>	cats, dogs, fish	-----
Metagonimiasis	<u>Metagonimus yokogawai</u>	cats, dogs, fish	-----
Opisthorchiasis	<u>Opisthorchis felineus</u> (and occasionally other species)	cats, dogs, wildlife fish	-----
Paragonimiasis	<u>Paragonimus westermani</u>	cats, dogs, wildlife	-----
Schistosomiasis	<u>Schistosoma japonicum</u> (and occasionally other species)	ruminants, swine, dogs, cats	-----
"Swimmer's itch"	<u>Schistosoma spp.</u>	birds, rodents	U. S.
(b) <u>Cestode diseases</u>			
Diphyllobothriasis	<u>Diphyllobothrium latum</u>	fish, carnivores	U. S.
Dipylidiasis	<u>Dipylidium caninum</u>	dogs, cats	U. S.
Hydatidosis	<u>Echinococcus granulosus</u> (Larval cyst stage) and occasionally <u>E. multilocularis</u>	dogs, ruminants, swine foxes, rodents	U. S.

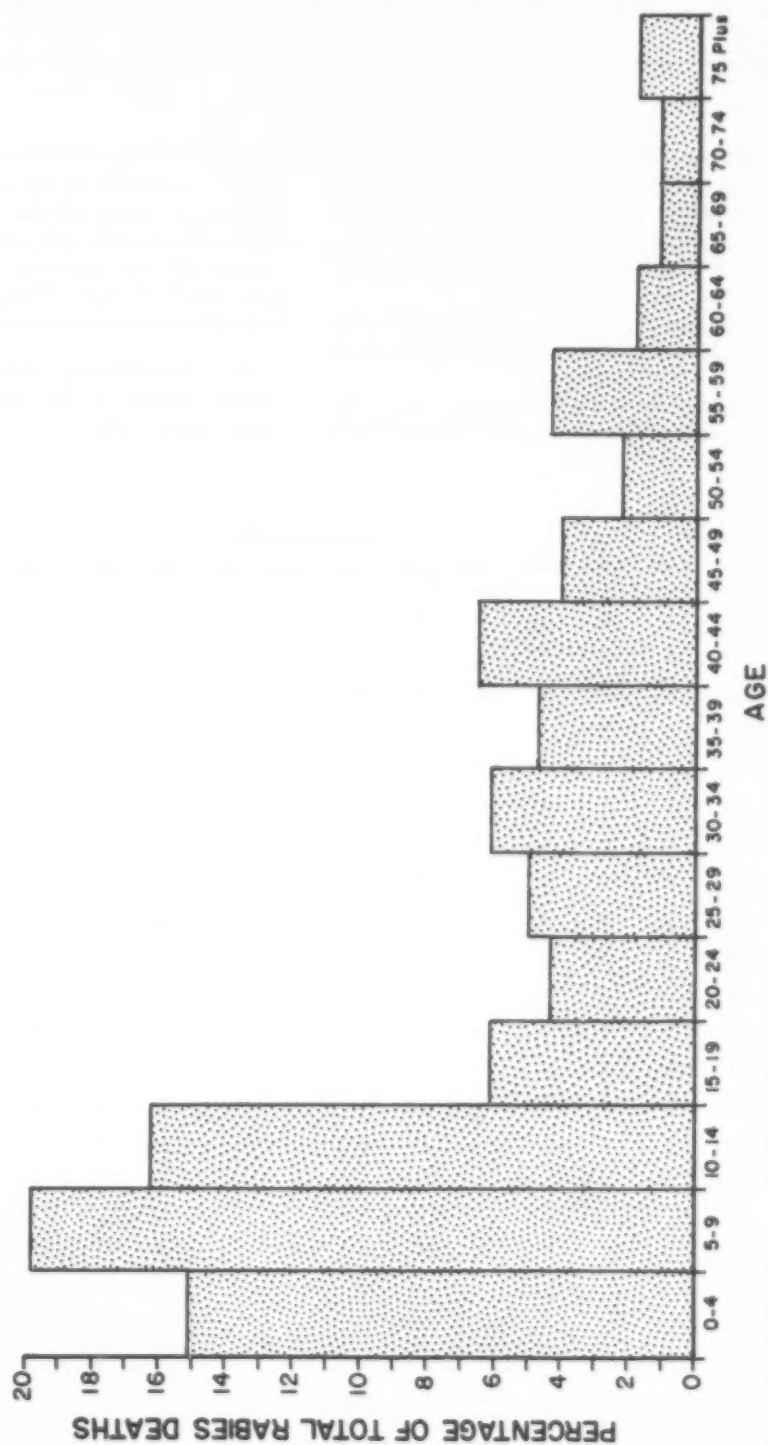
Hymenolepiasis	<u>Hymenolepis nana</u>	rats, mice	U. S.
Sparganosis	<u>Sparganum mansonioides</u> (and other species)	cats, mice and other mammals	-----
Taeniasis and cysticercosis	<u>Taenia saginata</u> <u>Taenia solium and its larval</u> <u>form Cysticercus cellulosae</u>	cattle swine	U. S.
(c) <u>Nematode diseases</u>			
Ancylostomiasis and cutaneous larvae migrans	<u>Ancylostoma braziliense</u> (and occasionally other species)	dogs, cats	U. S.
Strongyloidiasis	<u>Strongyloides stercoralis</u>	dogs	U. S.
Toxocariasis (visceral larva migrans)	<u>Toxocara canis</u> <u>Toxocara cati</u>	dogs cats	U. S. U. S.
Trichinosis	<u>Trichinella spiralis</u>	swine, rodents, wild carnivores	
Trichostrongyliasis	<u>Trichostrongylus colubri-</u> <u>formis (and occasionally</u> <u>other species)</u>	ruminants	-----

7. ARTHROPOD AND INSECT INFESTATIONS

Acariasis	<u>Dermatophagoides</u> spp., <u>Sarcoptes</u> spp.,	poultry, domestic animals, wildlife	U. S.
	<u>Trombicula</u> spp., etc.		

Bug-bites	<u>Cimex</u> spp., <u>Triatoma</u> spp., etc.	Chickens, birds, small mammals	U. S.
Flea-bites	<u>Xenopsylla</u> , <u>Ctenocephalus</u> , <u>Ceratophyllus</u> , <u>Tunga</u> , etc.	rats, dogs, cats, swine, birds	U. S.
Myasis	<u>Oestrus</u> , <u>Hypoderma</u> , <u>Gasterophilus</u> , <u>Cochliomyia</u> , etc.	ruminants, equines	U. S.
Tick-bites	<u>Ixodes</u> , <u>Dermacentor</u> , <u>Rhipi-</u> <u>cephalus</u> , <u>Haemophysalis</u> , <u>Amblyomma</u> , <u>Argus</u> , etc.	dogs, cattle	U. S.

TABLE 3
 PERCENTAGE OF HUMAN RABIES DEATHS IN THE UNITED STATES
 BY AGE GROUPS, 1944-1954



DHEW-PHS-BSS-CDC ATLANTA, GA.

870-93

NOV. 1956

NUMBER OF HUMAN RABIES DEATHS IN THE UNITED STATES*
1944 - 1954

Although the annual number of human deaths from rabies in the United States is small, the majority of these deaths occur among youngsters. The age group most vulnerable is the 5 to 14 year age group, followed by the group under 5 years of age.

Rabies deaths by age groups for the period 1944 to 1954 show that 20 percent of these deaths

occurred among children in the 5 to 9 year age group, 16 percent in the 10 to 14 age group, and 15 percent among children under 5. Age 15 to 49 years, 35 percent; and oldsters 50 years and more account for the remaining 13 percent. Thus, children under 15 years of age account for more than half of the total deaths from rabies.

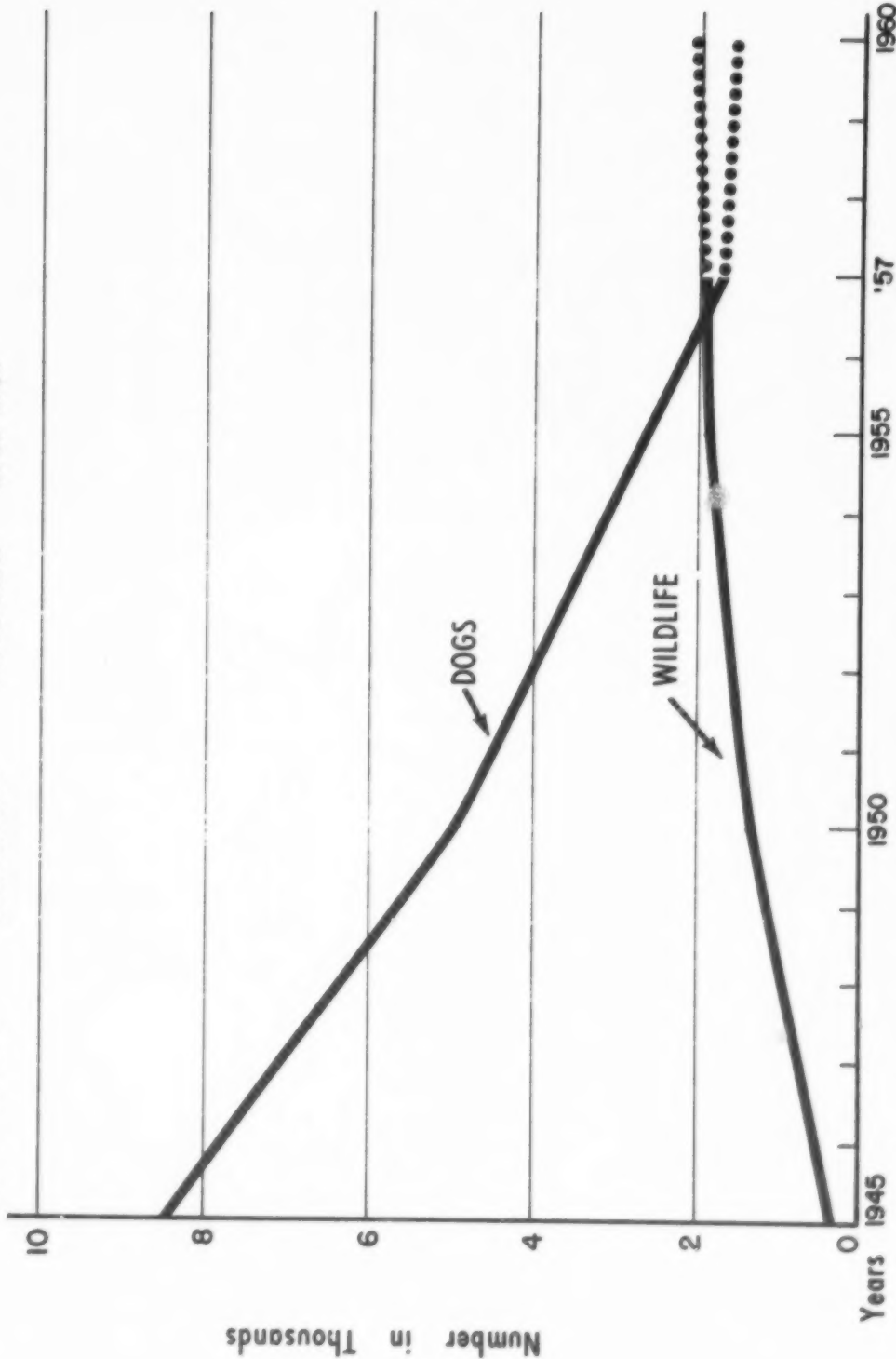
The accompanying table and the graph show rabies deaths in the United States during the years 1944 to 1954.

* Prepared by Statistics Section, Epidemiology Branch, CDC, from data furnished by the National Office of Vital Statistics.

Age in Years	Number of Deaths												Total	%
	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954			
0-4	6	6	4	6	4	1	1	4	2	3	5	42	15.1	
5-9	8	6	9	4	2	4	6	4	7	1	4	55	19.8	
10-14	9	10	4	5	3	2	6	2	2	2	—	45	16.2	
15-19	5	2	3	1	2	1	—	2	1	—	—	17	6.1	
20-24	1	1	5	1	1	1	1	1	—	—	—	12	4.3	
25-29	3	3	2	2	—	—	—	2	2	—	—	14	5.0	
30-34	3	2	3	3	2	—	1	—	1	1	1	17	6.1	
35-39	2	1	1	1	2	—	3	1	1	1	—	13	4.7	
40-44	3	5	2	—	1	—	—	2	4	1	—	18	6.5	
45-49	4	1	1	—	3	—	—	—	1	1	—	11	4.0	
50-54	3	2	—	—	1	—	—	—	—	—	—	6	2.2	
55-59	3	2	—	2	—	1	—	—	2	1	1	12	4.3	
60-64	1	—	—	1	2	—	—	—	—	—	1	5	1.8	
65-69	2	1	—	—	—	—	—	—	—	—	—	3	1.1	
70-74	1	—	—	—	—	—	—	—	1	1	—	3	1.1	
75 Plus	2	1	—	—	1	—	—	—	—	—	1	5	1.8	
Total	56	43	34	26	24	10	18	18	24	12	13	278	100.0	

Table 4

REPORTED ANIMAL RABIES 1945-1957



Wildlife includes: Fox-Skunk-Raccoon-Bats-etc.

TABLE 5
EXCERPT FROM THE THIRD REPORT** OF WHO EXPERT COMMITTEE ON RABIES
3. RECOMMENDATIONS OF POST-EXPOSURE TREATMENT OF MAN
52 GUIDE FOR SPECIFIC POST-EXPOSURE TREATMENT

NATURE OF EXPOSURE	CONDITION OF BITING ANIMAL		RECOMMENDED TREATMENT (NOTE: LOCAL TREATMENT SHOULD BE ENTERED)
	AT TIME OF EXPOSURE	DURING OBSERVATION PERIOD OF 10 DAYS	
I. No lesion; indirect contact only	rabid	-	none
II. Licks: (1) unabraded skin (2) abraded skin, scratches and unabraded or abraded mucosa	rabid a) healthy b) healthy c) signs suggestive of rabies d) rabid, killed, escaped or unknown	healthy clinical signs of rabies or proven rabid (laboratory) healthy	none none none start vaccine at first signs of rabies in animal start vaccine immediately. Stop treatment if animal is normal on 5th day after exposure start vaccine immediately
III. Bites (1) mild exposure	a) healthy b) healthy c) signs suggestive of rabies d) rabid, escaped, killed or unknown; or any bite by wolf, jackal, fox, bat or other wild animal	healthy clinical signs of rabies or proven rabid (laboratory) healthy	none start vaccine at first sign of rabies start vaccine immediately. Stop treatment if animal is normal on 5th day after exposure start vaccine immediately
(2) severe exposure: multiple, or face, head or neck bites	a) healthy b) healthy c) signs suggestive of rabies d) rabid, escaped, killed or unknown. Any bite by wild animal	healthy clinical signs of rabies or proven rabid (laboratory) healthy	serum immediately, no vaccine as long as animal remains normal serum immediately, start vaccine at first sign of rabies serum immediately, followed by vaccine, vaccine may be stopped if animal is normal on 5th day after exposure serum immediately, followed by vaccine

**WHO Technical Report Series, authorized for publication and distribution by Executive Board 16 January 1957.
NOTE: The above schedule applies equally well whether or not the biting animal has been previously vaccinated.

MILK IN RELATION TO NON-INFECTIOUS DISEASES

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When I was invited to come down and talk about milk in relation to non-infectious diseases, I wondered what one could say about milk in relation to any disease for milk is usually associated with health. I never had associated milk with disease other than infectious disease. I had to think for a few minutes to figure out what to say in relation to milk and its association with non-infectious disease.

I suppose there are diseases that develop when you get too much milk and when you don't get enough of it.

In the category of diseases associated with too little milk - I thought of two diseases, both of which are very rare in this country because this is a well-nourished country. One is Marasmas, which is simply starvation in infants, and the other is a disease called Kwashiorkor disease about which much has been written in the nutritional literature during the last half dozen years. I would say that Marasmus and Kwashiorkor are two diseases that are very frequently associated with a lack of milk. This is a slight misnomer, however, as it is caused by the lack of something to eat and primarily those foods which are good sources of protein. Milk is a good source of proteins.

Then in the other category, of diseases that may be associated with too much milk, there is a condition known as hypercalcemia of infancy. Also there is a fair amount of clinical opinion that kidney stones and arthritis are associated with the consumption of too much calcium in the diet. For example, as you people in public health probably know, it is occasionally suggested that kidney stones, kidney calculi, are more prevalent in the milk-producing States of Wisconsin and New York than they are in a number of other States which are non-milk producing. I don't know of any valid evidence of this point.

There is a condition known as milk-alkali disease, which is occasionally associated with the old fashioned treatment of ulcers when baking soda and similarly soluble alkalis were used. However, any relation that these diseases have to milk, insofar as I know, is only indirect. In the last decade there has been considerable interest in a variety of studies having something to do with coronary artery disease, and milk has been dragged into these to some extent, because milk and milk-products are the major source of fat in the American diet.

Since some of these diseases that I have mentioned are quite rare in this country, there is no point in spending time on them at this meeting. I did think that it might be well to review briefly for you something about the nutritional composition of milk, because the main virtue of milk is that it is a good food - it comes closest to what some speak of as a perfect food. However, there is no such thing as a perfect food, if you define a perfect food as a food which supplies all the nutrients that one needs to be well nourished. Milk is extremely low in iron, and one of the easiest ways to produce a simple iron deficiency anemia experimentally is to see that milk is the sole source of food for rats.

In teaching medical students at Harvard something about the composition of milk, I usually put on the board the comparative composition between milk and beer. You can usually get their attention by saying that actually if you compare the nutritional composition of milk and beer, you will find out that beer is eight times more nutritious than milk, in regard to niacin. You always have to add the statement "with regard to niacin." Niacin is one of the important B vitamins. It is the one that has been associated classically with pellagra. From the comparison one will note beer has 8 milligrams of niacin per quart, and milk has none, so you could say that beer is eight times more nutritious with regard to niacin. That usually will wake the students up, and they will be able to hang their hats on that fact. You then can go ahead and mention that with regard to calories, beer and milk for all practical purposes are the same, somewhere around 500 to 600 calories per quart. When you study the protein, however, which is a pretty important constituent of nutrition, a quart of milk has somewhere around 33 grams of protein. This means that an eight ounce glass of milk has around 8 grams of protein, which is a sizeable contribution. In comparison an egg provides somewhere around 6 to 7 grams of protein, and an average serving of meat will provide 15 to 18 grams of protein. So anybody who gets a glass or two glasses of milk a day is getting a fair portion of good quality protein.

There is also the differences in butterfat and the carbohydrates. Let us consider calcium. Practically every school child knows you should have milk in the diet to provide calcium and phosphorus for bones and teeth. Milk is our single best food for calcium and phosphorus. The only catch is that I think many nutritionists have been over enthusiastic about the virtues of calcium in our diet. I think I can almost say that no ill health any place in the world has ever been shown to be caused by not having enough calcium in the diet. Many of you will immediately say, "what about rickets?" Rickets is primarily a disease associated with the lack of vitamin D rather than with the lack of calcium in the diet. I don't know of any other physiological substance in which the body has such an ability to adapt itself to as the amount of calcium in the diet. A person who consumes two, three, or four glasses of milk a day would have a high calcium intake. Your body adjusts itself to such a high calcium intake, and you are in calcium equilibrium, absorbing little and excreting a good bit of calcium. On the other hand, if an adult has no milk in the diet, he may have a calcium intake of as low as 250 milligrams and be in calcium equilibrium, absorbing more and excreting less. We are not very efficient absorbers of calcium, and the more calcium you have in your diet the less you absorb and also the more you will excrete.

From the viewpoint of cardiovascular disease, which I will be talking about later, the content of sodium is important. There is about a half gram of sodium in a quart of milk. People who are on a sodium low diet must have an extremely low intake of sodium for it to be much good, can not have much milk because milk is a potent source of sodium. We really don't speak of low sodium diets until the sodium content is in a range of 100-200 mgs. per day so that if you have much milk in the diet you are up to the maximum level very quickly. On the other hand the foods, which we classically eat with milk, the breakfast cereals, particularly wheat and rice products, are very low in sodium. The question arises as to how are you going to have corn flakes without milk? Well, an interesting way that a number of other clinics have used in the last few years with considerable success is to have corn flakes or any other cereals with beer instead of milk.

At first that sounds terrible, but you try it sometime. Take a dish of any kind of cereal, and consume it with beer. It makes a very good low sodium food particularly if you use one of these newer cereals that are rich in proteins. Another advantage is that beer is low in sodium and is a diuretic.

I might say just a few words about this milk-alkali syndrome. It certainly isn't common any more and came about simply because of the historical way of treating peptic ulcers with milk and an alkaline powder. One report of about ten years ago describes a number of individuals who were consuming lots of milk and lots of sodium bicarbonate and who developed a disease syndrome characterized by an increased concentration of serum calcium, and deposition of calcium in the membranes of the eye and other tissues. Kidney damage was described in some patients, which was not associated with increased urinary output of calcium or with alkalosis.

In this syndrome of increased calcium in the blood and deposition of calcium in various tissues of the body, one has to think of other things that may give rise to the same condition. One of these disorders is caused by too much vitamin D. Hypervitaminosis D is such a disorder. Ten to fifteen years ago excessive amounts of vitamin D were occasionally used with the idea that it might be helpful in arthritis. This excessive intake of vitamin D leads essentially to the same syndrome. Hyper-function of the parathyroid glands can also produce hypercalcemia in a syndrome similar to the milk-alkali disease. Certain types of tumors of the bones can give rise to such conditions. The physiological mechanism that causes this disturbance of increased calcium is not fully understood. However, it is of interest where in considering milk in relation to non-infectious diseases, that the milk-alkali syndrome is one that results from the efforts of the physician and patient to achieve relief from distressing pain and other symptoms of a common disease - peptic ulcer. However, I think it would be unfortunate to impune milk, which is a good valuable food, because of the occasional occurrence of this disorder. I think the place of milk in the diet of a patient with peptic ulcer will and should be retained. It would seem, to be of importance, however, to restrict the use of alkaline powders. With this thought in mind the pharmaceutical companies have come up with ulcer treatment materials which are relatively insoluble. One does not have the excessive absorption of calcium, and these alkaline powders are the ones that most physicians now recommend. Most patients take the non-absorbable alkalis, such as aluminum hydroxide and magnesium trisilicate. This syndrome is not found as a result of the treatment for ulcers using aluminum hydroxide or magnesium trisilicate.

This brings us to the group of diseases order - the group of diseases in this country which are really very common and by which milk has been brought into the picture because of its content of fat. These are the vascular diseases and primarily the coronary artery disease. Until approximately a decade ago, this disease was considered as a degenerative disease - a disease of old age and one you couldn't do much about. Then

people in various parts of the world began discovering that there were really large groups of people in various parts of the world where coronary artery disease was a rare disease. It seemed strange that you could find large numbers of people where this disease was rare and in other areas, particularly those of Western civilization where it was quite high. Why the difference? Well, there were a number of differences that came into the picture, a good many of which deal with nutrition and some of which deal with fat.

(Slides were introduced at this point)

The slides show results of some important studies that we conducted four or five years ago with a group of Guatemalan Indians, studies done in cooperation with INCAP, the nutrition institute located in Guatemala City. We suspected that these people might have very little coronary artery disease. Our studies covered three phases; nutritional history studies, chemical studies, and some studies in clinical examination and pathology. The rural Guatemalan has a caloric intake of about a thousand calories less than the comparable group in the United States we were studying. Of those total calories only eight percent of the calories were coming from fat, as compared with 40 percent of the calories of the United States urban group with which we were comparing. The group under study were males between the ages of 40 and 50 years of age.

We were interested in knowing what the differences were in cholesterol levels. The group of rural Guatemalans averaged about 140 milligrams cholesterol. The American males averaged about 100 milligrams higher.

We have two definite things we can talk about. One is that these Guatemalans are receiving far less fat in their diet and that their serum cholesterols are much lower. What do these people die of? There was no difference in the degree of atherosclerosis between the Guatemalans and the American until about the age of 25. Then the rate of increase began rather rapidly in both groups, but much more so in the American. Actually, they didn't begin to go up in the Guatemalans until about 35 years of age. Another interesting thing is that most of us who put on weight do so when we get in the middle 20's. Most adults who really put on weight put it on between the ages of 25 and 40. This appears to be the period where atherosclerosis, determined at autopsy, increases.

In speaking of coronary artery disease, we are much more interested in people who have infarction, as shown by clinical evidence, or who have had a clinical event rather than just the fact that they have atherosclerosis.

It is far more striking that out of the autopsy material, which we had available, the incidence of coronary atherosclerosis was about the same before 25-30 years of age. The incidence was in the older age groups. Of much more interest is the fact that out of 316 subjects from our country over 40 years of age, there were 51 cases of fatal myocardial infarction whereas in 234 males from Guatemala over age 40 there was only one case of myocardial infarction. The big difference in these groups is really the incidence of coronary infarction and not the incidence of atherosclerosis.

We have studied the group from Guatemala; other people have studied groups from other parts of the world. When you take groups of people with markedly different diets, one of the things you run across is the fact that there is much less fat in some of the diets. There are also a number of other nutritional differences between such groups of people, which may have something to do with their disease. One difference is the type of carbohydrate. Most individuals living in so-called primitive parts of the world on primitive diets have diets which are characterized not only by being low in fat, but also diets which are extremely low in sucrose. Their source of carbohydrate is starch obtained from some root vegetable. There is a big difference between the type of carbohydrate starch versus sucrose. This comes into the picture with regard to the secretion of bile which is the only way we have of getting rid of cholesterol.

There are marked differences in the protein content of the diets. Our diets tend to be high in protein and high in animal protein obtained from milk and meat. The diets of other parts of the world are low in protein, and the main source of protein is the vegetable protein rather than animal protein. There are also some differences in vitamin and mineral compositions. In relation to cardiovascular disease we have heard much more about differences in fat. I am sure all of you have heard about unsaturated and saturated fat in relation to this condition. There are also many other nutritional differences between these groups of people.

Let us take up the experimental studies we have done with monkeys. Our laboratory has been the principal laboratory utilizing the monkey in cardiovascular disease research. We started with the monkey, 8 or 10

years ago, principally on the assumption that if we were working with a primate the observations might have a little more application to you and me than they would with a non-primate, such as a rodent. The level of cholesterol of the monkey runs somewhere around about 150 milligrams percent, about the same level as our Guatemalan subjects. The American cholesterol levels as you will see later run appreciably higher.

One can influence the cholesterol level of the monkey very readily by dietary manipulation. It can rapidly be boosted from about 120 or 140 mg. percent to 500 to 600 by putting large quantities of fat in the diet. Also, in this case, the diet consisted of a poor source of protein. This protein was poor in the amino acid and cystine. We find very extensive atherosclerosis in monkeys with experimentally elevated levels of serum cholesterol.

Should you examine the heart of such a monkey after sacrifice, you will note the deposits of atheromatous plaques located at the aortic valve. The right coronary artery may be half plugged with atherosclerotic plaques as well as the left coronary artery. Atheromatous deposits may also be found in the arch of the aorta. We have such conditions in monkeys which we may assume have been produced experimentally.

One can manipulate the serum cholesterol level again by changing the fat content of the diet. This slide shows results with six monkeys which start out with cholesterol levels of around 150. Several of the animals had lard as the source of fat in the diet. The other animals had corn oil. The diets purposely had cholesterol added in order to increase the blood cholesterol levels. They all increased during the first three weeks of the study, but after about three weeks, the three animals in which corn oil was the fat had a much lower cholesterol than with those in which lard was the source of fat. During a later period the sources of fat were changed. The animals which were getting lard in the diet received corn oil, and the animals which were getting corn oil in the diet received lard. Lard favored an increase of cholesterol, while corn oil kept it lower.

When you can produce a disease experimentally, it is a lot easier to study it. It is a lot easier to work with monkeys and rats than it is to work with people; and, if you can produce it experimentally, you can do various types of things to try to prevent its development. Atherosclerosis has now been produced in six or seven different species of animals, historically in the rabbit, but in the last ten years in the monkey, rat, guinea pig, chick, hamster, and dog. Generally you can

only produce it when you can produce an elevation of serum cholesterol. You can make the statement that you cannot produce atherosclerosis experimentally unless something is done that gives a rise in blood cholesterol.

In quite a few studies in man, there is no question but what coronary disease is far more prevalent in individuals who have elevated serum levels of cholesterol. This is the reason we give so much emphasis to the importance of the blood cholesterol. I emphasize blood cholesterol for this reason. Many practicing physicians give some attention to the cholesterol content of the diet. Yet from the experimental viewpoint, there is excellent evidence to show that the cholesterol content of the diet has very little to do with the cholesterol content of the blood. From a practical viewpoint whole milk and eggs are the main source of dietary cholesterol. An egg provides about 300 milligrams of cholesterol. If you have two eggs for breakfast you have 600 milligrams of cholesterol. Should you have a glass of milk, you get about another 150 milligrams of cholesterol. Which brings you to 750. From the rest of the material in your food, particularly if you have much meat in your diet, you will pick up another 150 to 200. So, for all practical purposes, you can say that a diet in which you have two eggs a day, either as such or utilized in cooking, and a glass of milk you have a cholesterol dietary intake of around 800 to 1000. Eliminate the two eggs and the milk and you are down to somewhere around 200. However, it doesn't make any difference because the cholesterol content of the diet has very little to do with the disease. What does influence the cholesterol of the blood? Well, the things that influence it so far as we know are: (1) gain or loss of body weight, the second thing is the type of fat in the diet.

What about types of fat? Speaking of fats in the diet, there are characteristically three types, saturated fats, monounsaturated fats, and polyunsaturated fats. The nomenclature is derived from the number of double bonds in the fat molecules. A common example of a completely saturated fat would be cocoanut oil. Cocoanut oil is principally made up of a fatty acid called lauric acid which has 12 carbon atoms in a chain with no double bonds. A monounsaturated fat has one double bond in it; and the most common examples of a monounsaturated fat would be lard and butter, which are principally oleic acid. Peanut oil, cottonseed oil, and corn oil are common examples of polyunsaturated fats, which means that the principal fatty acids have two double bonds in them. The principal polyunsaturated fatty acid is called linoleic acid. The principal common fats available to us that are polyunsaturated are corn oil and cottonseed oil. You drop down to the animal fats like butter, which has monounsaturated fats and about half way

between you will find peanut oil. The completely saturated fats are not usual in our diet because we do not use cocoanut oil in our diets, to any great extent. Cocoanut oil is occasionally mixed with margarine and butter.

You hear about hydrogenation and the effect of hydrogenated fats in the diet. Most of the cooking shortenings are primarily hydrogenated soy bean oil. In the process of hydrogenation, you take a polyunsaturated fat and saturate some of these double bonds. You usually produce a monounsaturated fat. The reason I mention this is because some studies with man, and some with animals, show the monounsaturated fats, which means butter, lard, animal fats, and most of the shortenings, tend to increase the level of cholesterol in most experimental studies, whereas the polyunsaturated fats like corn oil and cottonseed oil tend to lower it. This is where the idea has come about that "saturated" fats are bad; unsaturated fats are good. Most of the people who write and talk about this speak a little too loosely, because they speak of saturated versus unsaturated fats. To be correct, it should be monounsaturated versus polyunsaturated fats, the "mono" being oleic acid, the "poly" being linoleic acid.

One of the interesting findings that has come from our laboratory in recent years has been that the completely saturated fats like cocoanut oil seem to act synergistically with the polyunsaturated fats and tend to keep the cholesterol down. It may be the monounsaturated fats that conceivably are not too desirable. Now, the whole question of the fat in the diet is relative, because it depends on the ratio of all these things in the diet.

I want to give you just a little idea of where the fat in our diet comes from and the role of milk in supplying fat. A typically American diet, possibly a little on the low side provides 118 grams of fat. I think most of us in this room probably consume 125 to 140 grams of fat. We get about 30 grams of fat from meats, about 20 grams of fat from whole milk products including that used in cooking, none from skim milk, 12 grams from eggs, 25 grams from butter or margarine, salad oils, pastries, cereals and other foods. Assume that you eat butter, calling butter a milk product, you have 45 grams of fat coming from whole milk products. These are minimal figures.

Some nutritionists feel that it would be desirable to cut the fat content of the American diet in half. We would have instead of approximately 40 to 45 percent of our calories coming from fat, somewhere around 20 to 22 percent. It might be desirable if we could increase the

amount of polyunsaturated fats, in this decreased fat intake. Obviously, if you cut the fat in half, it will be necessary to cut most of these fats in half. Then if with this decreased amount of fat you would want to double the amount of polyunsaturated fat, you would have to cut some of these monounsaturated fats still more. If one should do this, it would mean that whole milk products are out, but on the other hand, one would increase the amount of skim milk to keep the protein content in the diet up.

If one wants to cut the fat in the diet in half and double the amount of polyunsaturated fat, it means drastic decreases in meat, whole milk, butter, eggs, margarine, and pasteries, made with monounsaturated fats. I think a definite trend in this direction is beginning to appear in the American diet. I believe the change will continue for some time. I don't for a minute believe that we are going to wholly eliminate these foods, but I do think they will be decreased. I do think that cereal consumption in the United States which has been going down hill for the last generation is to start going up hill. This is particularly true now that cereal manufacturers have begun to improve the nutritional quality of their cereal foods. This is being done by increasing the amount of proteins. Really the cereals are a very good source of protein provided they are consumed in sufficient volume. The cereals, as we consume them are almost devoid of fats, because in general the oil has been taken from the grain while the rest of it is made into cereal.

While most of this talk has dealt with various nutritional factors in relation to certain aspects of cardiovascular disease, I would not desire to close this talk without mentioning that there are a half a dozen other elements that are associated with this disease. There is no question, but that hereditary factors play a very important role in cardiovascular disease just as important as they do in diabetes. Overweight plays an important part as certainly any life insurance company in this country realizes. I think that most physicians, but by no means all, feel that people with coronary disease are more apt to have an elevated blood cholesterol. It is certainly a disease which has a strong correlation with high blood pressure. High blood pressure is an aggravating factor, and I don't think there is any question but what coronary artery disease is far more prevalent in people who are heavy cigarette smokers than in those who are non-cigarette smokers. Most of the studies that have been done with smoking in relation to cancer of the lung have shown also that cardiovascular disease is far more prevalent. There isn't any evidence that stress and strain and hard physical work, as far as I know, are associated with cardiovascular diseases. In fact, there is some good

epidemiologic data showing that this disease is less prevalent in people who are more active physically. I know of practically no evidence that psychological stresses and strains have much to do with this condition. I think one of the interesting things that has come out of recent researches is the additive nature of these things.

I would simply say in conclusion, to get back to milk again for a minute, that milk continues to be an important food - there's not any doubt about that - it is an important food in this country. I think that with our abundance of food and the great variety of foods that we have available, its importance might have been somewhat overrated by overly enthusiastic nutritionists, who have misinterpreted a good bit of research data having something to do with calcium balance studies. They have misinterpreted the so-called recommended dietary allowances of the food nutrition boys. Milk is certainly a highly desirable food for infants and children and for adolescents, but when too much milk for children crowds out other foods in the diet, it is not, in my opinion, a desirable practice. I think it is ridiculous to try to get children to drink a quart of milk a day or a quart and a half of milk a day at the expense of crowding out other foods. Milk is also a desirable, but certainly not an essential, constituent of the adult diet. This milk-alkali syndrome about which I mentioned a few words is an uncommon finding today with the newer types of anti-acid substances. The consumption of whole milk, cream, and butter may be restricted in individuals who have had coronary thrombosis, cerebral hemorrhage or in who these disorders might be anticipated. Because of its calories, whole milk products might be restricted in obesity. Since, milk in all forms is a rich source of sodium, milk and its products are restricted in low sodium diets used for the treatment and prevention of hypertension and also any other type of edema.

Lastly, despite these comments along the line of the subject that I was asked to talk about- milk in non-infectious diseases - please remember that milk remains an excellent food, one of the best and contributes importantly to the American diet.

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